ORIGINAL

ANALYTICAL WATER SOLUTIONS, LLC
9850 N. 19th Dr. #4
Phoenix, AZ 85021

Thomas Trimble, P.E.

Facsimile (602) 944-2996
E-Mail wwtp1242@cox.net

57

RECEIVED

2007 JAN 24 P 3:41

AZ CORP COMMISSION
DOCUMENT CONTROL

January 23, 2007

Arizona Corporation Commission
DOCKETED

JAN 24 2007

DOCKETED BY | NR

Mr. Paul Levie
Antelope Lakes Water Company, Inc.
2465 E. Shane Dr.
Prescott, AZ 86305

RE: Arsenic Removal Study

Dear Mr. Levie:

Enclosed herewith is the completed study and recommendation for removing the arsenic and fluorides from Well No. 55-902169 for Antelope Lakes Water Company, Inc.

The required number of copies have been submitted to the Arizona Corporation Commission for their review (File No. W-02740A-05-0089).

Please call, should you have any questions.

Respectfully Submitted,

Maurice Lee

Maurice Lee, Manager
ANALYTICAL WATER SOLUTIONS, LLC

cc: Arizona Corporation Commission
File No. W-02740A-05-0089

ARSENIC REMOVAL STUDY

FOR

ANTELOPE LAKES WATER COMPANY, INC.

2465 Shane Dr. Prescott, AZ 86305
(928)778-2600

WELL NO. 55-902169

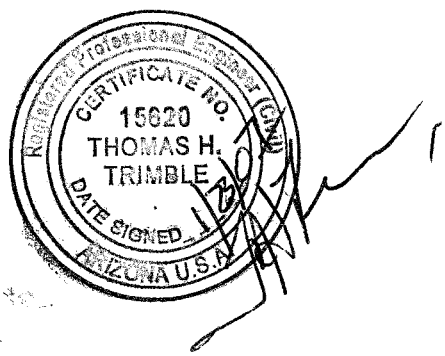
PWS No. 13-0426

PREPARED BY

ANALYTICAL WATER SOLUTIONS, LLC
9850 No. 19TH Dr. #4 Phoenix, AZ 85021
(866)330-7980 Fax (602)944-2996
wwtp1242@cox.net

January, 2007

TABLE OF CONTENTS



INTRODUCTION

At the request of Mr. Paul Levie of Antelope Lakes Water Company, Analytical Water Solutions, LLC has completed arsenic and fluoride testing on the Wineglass well for Antelope Lakes Water Company reference as Well No. 55-902169. The Wineglass well is located near the intersection of Bull snake Road and Wineglass Ranch Road, more specifically the Wineglass well is located in the NW ¼ of the SW ¼ of the NE ¼ of Section 24, Township 18 North, Range 3 West of the Gila & Salt River Base & Meridian, Yavapai County, Arizona.

The United States Environmental Protection Agency (EPA) with Arizona Dept. of Environmental Quality (ADEQ) following, has set the arsenic standard for drinking water at 0.01 parts per million (ppm or mg/l) or 10m parts per billion (ppb) to protect the consumers served by public water systems from the long term effects of chronic exposure to arsenic. Water systems have had to comply with this standard since January 23, 2006, providing protection to an estimated 13 million American. Fluoride has a standard of 4 ppm.

The non-cancer effects of arsenic can include thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in the hands and feet, partial paralysis and blindness. Arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Fluorides above 1.7 ppm has been proven to have adverse on children's teeth and have been linked to making people's bones more brittle and breaking easier.

The water in the Wineglass well has levels of arsenic above 2,100 ppb and has fluorides at levels from 8.8 ppm to 9.5 ppm. This study was conducted to determine if it was possible to treat the water to remove the arsenic and fluoride levels to below the maximum contaminant levels (MCL) of 10 ppm and 4 ppm respectively.

BASIC DATA COLLECTION

Analytical Water Solutions took water samples from the well to be tested independently to verify the levels of arsenic as well as fluorides. One gallon water samples were taken and were sent to laboratories in the Phoenix area to find that they agreed with water samples collected by Antelope Lakes Water Company. Copies of the laboratory analysis at herein attached.

Analytical Water Solutions then collected 500 gallons of water and transported to their facilities in Phoenix to completed further testing and to complete pilot test with reverse osmosis units as well as other medias.

WATER TESTING

During the month of May, 2006 and again in the months November and December, Analytical Water Solution conducted test and completed pilot testing of the Wineglass water to determine how much arsenic and fluoride could be removed by using first reverse osmosis and then by filtering the water through iron based media from ADI International and by Alcan Specialty Alumina. The media by ADI International is trade named and patented as MEDIA G2 while the

media by Alcan Specialty Alumina is trade named and patented as AASF50. Both medias are "NSF" approved and have been tested by the U.S. Environmental Protection Agency (EPA), "The Environmental Technology Verification Program" (ETV). The reverse osmosis units used in the test were manufactured by Watts Premier. The ETV Joint Verification Statements of ADI, Alcan, and Watts are herein attached for reference.

Testing of the pilots were conducted on site using the following EPA approved test kits:

Arsenic	Quick Low Range – 1 Industrial Test Systems, Inc. 1875 Langston St. Rock Hill, SC 29730	Fluoride	LaMott 1200 Lamott 1802 Washington Ave. Charlestown, MD 21612

Testing comprised of running 0.25 gallons per minute through the reverse osmosis unit the adjusting the pH of the water to 6.5 and then running the pH adjusted water through a gravity filter holding the iron base media of ADI then Alcan. Before each run of the water, the reverse osmosis unit and the gravity filters were rinsed with distilled water for a period of 10 minutes each. New media was placed in the gravity filter before each run. Each run consisted for two hours before taking a sample and testing it.

July 29, 2006
Pilot Test #1

Contaminant	Raw Water	After R/O	After ADI	After Alcan
Arsenic	2,100 ppb	185 ppb	6 ppb	< 2 ppb
Fluoride	9.5 ppm	0.09 ppm	-	-
TDS	1,600	158 ppm	-	-
pH	9.49	8.2	6.8	6.8

November 10, 2006
Pilot Test #2

Contaminant	Raw Water	After R/O	After ADI	After Alcan
Arsenic	2,100 ppb	210 ppb	6 ppb	< 2 ppb
Fluoride	9.5 ppm	0.10	-	-
TDS	1,600 ppm	160 ppm	-	-
pH	9.49	8.2	6.8	6.8

December 1, 2006
Pilot Test #3

Contaminant	Raw Water	After R/O	After ADI	After Alcan
Arsenic	2,100 ppb	199 ppb	7 ppb	< 2 ppb
Fluoride	9.5 ppm	0.10 ppm	-	-
TDS	1,600 ppm	152 ppm	-	-
PH	9.49	8.2	6.8	6.8

CONCLUSIONS & RECOMMENDATIONS

Analytical Water Solutions, completed the testing and pilot test from the Wineglass Well No. 55-902169 drilled by Antelope Lakes Water Company. Over a six months period. Care was taken not to contaminate the water samples with other sources. Testing and sampling was conducted in a professional manner in a accordance with standards in the water industry. Proper preparation was completed to insure the accuracy of testing on site and in the field.

It was concluded that the high levels of arsenic, fluorides and total dissolved solids (TDS) could be treated to a level that was within the MCL of both EPA and ADEQ. The Wineglass well having an arsenic level above 2,000 ppb and a fluoride level of above 9 could be treated to levels below the MCL. It must be noted that in order to effectively use the iron based medias of ADI and the modified activated alumina of Alcan, it was necessary to adjust the pH to at least 6.5. Better results may also be realized by lowering the pH to 6.0, however, by doing this, it would be necessary to raise the pH to a higher level before consumption.

Analytical Water Solutions recommends that the treatment process by a two part process utilizing a reverse osmosis system then processing the water though a duplex filter arrangement of a tested media that is "NSF" approved. A duplex tank arrangement is recommended because of the need to change out the media or to regenerate the media. Analytical Water Solutions recommends that a media be used that does not require regeneration because of operator simplicity and the dangers of storing chemicals on site and also the disposal of the regenerated waste than occurs when regenerating. The spent media from Alcan Specialty Alumina (AASF50) has been tested to pass the Total Character Leaching Procedure (TCLP) meaning that the spent media can be taken to a land fill for disposal without any special treatment and is not classified as "Hazardous Waste".

It must be noted that a reverse osmosis (RO) unit does generate a waste stream that has to be taken into consideration. For every gallon of water treated , there is a waste of 20 to 30 percent that has to be disposed of. This can be taken care of by building an evaporation pond. The evaporation pond has to be lined with a least a 20 mill pvc liner according to ADEQ rules and regulations. It is possible to enhance the evaporation by installing misting fans around the perimeter of the pond or ponds. Proper engineering would have to be completed and submitted for approval along with the design of the media filters using a media that is "NSF" approved.

Analytical Water Solutions recommends that the media filters be designed to treat 100 gallons per minute (gpm) and the reverse osmosis (RO) units be phase for 60 gallons per minute for the first phase and the to add a 40 gpm unit when needed. Also needed would be the well head improvements, booster pumps, pressure tank, storage tank and building to house the treatment system. In lieu of using 93% sulfuric acid to lower the pH, carbon dioxide can be used and even citric acid can be used to lower pH. A recommended layout of the RO and media filters are herein attached.

Using a number of 250 gallons per day for each consumer, 60 gallons per minute of treated water would accommodate 345 lots. In the expansion of 40 gpm to 100 gpm capacity, the capacity would be 576 lots.

COST ESTIMATE

DESCRIPTION		Phase I	Phase II
Site Grading and Preparation		$ 15,000	
Well head & Well Improvements		22,500	
Booster Pumps		7,500	
2,500 Gallon Pressure Tank		5,000	
2 – 100,000 Gallon Storage Tanks		65,000	65,000
Yard Piping		7,500	5,000
Reverse Osmosis - 60 GPM		42,500	
Reverse Osmosis - 40 GPM			39,500
2 – 5" Dia. Filters w/Valve tree		61,181	
Chlorination System		1,500	
PH Adjustment		1,500	
12,766 # Alcan Media AASF50		15,319	
Fencing		12,500	
Building		35,000	
Evaporation Pond		43,560	43,560
	Total	$ 335,310	$ 165,463
	Engineering @ 14%	46,043	
	10% contingency	33,530	
	Total	$ 415,783	$ 415,783
			$ 581,246

Note: Arsenic and Fluoride Removal $120,500

$415,783 Divided by 345 Lots = $1,205/Lot
$581,246 Divided by 576 Lots = $1,009/Lot

Operational Cost

$0.25 per 1,000 gallons of treated water

ANALYTICAL WATER SOLUTIONS, LLC
9850 N. 19th Dr #4 Phoenix, AZ 850021

(602) 795-7980
Toll Free (866) 330-7980
Facsimile (602) 795-7983
wwtp1242@cox.net

January 15, 2007

Mr. Paul Levie
Antelope Lakes Water Co. Inc.
2465 Shane Dr. Prescott, AZ
P.O. Box 350
Chino Valley, AZ 85323

RE: Arsenic Removal Treatment Plant – Chino Valley, AZ

Dear Mr. Levie:

We am pleased to offer this proposal to furnish a complete water treatment system to remove the arsenic and fluoride from your proposed water source for the above referenced project. All components of the system as proposed including the media of iron enhanced activated alumina is certified to **"NSF" 61** and an Alamo Reverse Osmosis unit. The process meets or exceeds United States Environmental Protection Agency (EPA) and Arizona Dept. of Environmental Quality (ADEQ) requirements for removal of arsenic and fluoride from a potable water source. The system proposed would remove the fluorides level to below 4 ppm and the arsenic to a level below the 10 ppb that EPA and Arizona Dept. of Environmental Quality (ADEQ) has established effective January 23, 2006.

Design Parameters

1. Arsenic (As) Level	2,100 ppb
2. Ph	9.49
3. Peak Flow	100 Gallon Per Minute (gpm)
4. Dailey Use	144,000 Gallons Per Day (gpd)

Process Sizing

1. EBCT	7 Minutes per vessel
2. Operating Ph	6.5
3. Filter size	5.0' dia. X 8' Side Shell
4. Bed Depth	5.0 Feet
5. No. of filters	2
6. Media (AASF50)	96 cu. Ft./Filter
7. Flux Rate	2.0 gpm/s.f.
8. Filter Rate	100 gpm
9. Backwash Rate	50 gpm/Filter

Treatment System

1. Two (2) 60" diameter x 96" steel filter vessels with legs, 14"x 16" hatch opening on top and a 14" x 16" hatch opening on the side. Inside coating to be **Epoxy coated to NSF 61** specifications. Outside prime coated and painted to owners' specifications. Tanks to be 125 psi rated.
2. One Alamo R-48-12 Reverse Osmosis system capable of 60 gallons per minute (gpm). ETV verified by EPA for arsenic removal
3. All 3" schedule 80 PVC piping and valves to have the system operate in parallel and/or lead/lag mode. Valves marked with tags that agree with operation and maintenance manual (O&M). All pvc piping to be painted with ultra violet resistant paint.
4. All in-line flow meters on inlet side of treatment system. Pressure gauges to be on inlet and discharge sides of the treatment system.
5. Ph adjustment system for the treatment system as required by the supplier of the iron enhanced activated alumina media.
6. 196 cubic feet of Alcan AASF50, 14 x 28 iron enhanced activated alumina certified by **"NFS 61"**
7. Complete system to be completely assembled on site by Analytical Water Solutions, LLC.

8. Connection to the well and distribution system by others.
9. Delivery to Chino Valley, Arizona at a designated site by owner.
10. Two (2) Days start up and training of operator.
11. Complete shop drawings on auto cadd to be approved by owner and engineer. Complete engineered drawings for approval by ADEQ and/or Yavapai County. Engineering drawings to be complete with design report with both plans and report to be furnished to Moore & Associates Engineering in electronic format. As part of the design analysis, Analytical Water Solutions to perform bench test using reverse osmosis and filtration system using AASF50 media to be a part of the design report to show the effectiveness of the system to be installed. (Water already collected from well by Analytical Water Solutions, LLC.
12. Operation and Maintenance manuals and "AS Builts" upon start up of the system.
13. Filters assembled on site and filled with media (Concrete pad & Building by others)
14. Process warranty to remove the arsenic below 10 ppb effective one year from start up of system. Warranty of parts and materials in the arsenic removal system shall be for two years after start up of the system
15. Analytical Water Solutions, LLC to furnish "Certified Operator" for one year to assist in the operation of the arsenic removal system on a monthly basis. Operator of the water system to be by others.

Excluded

1. Site preparation including any grading or excavation.
2. Crane to unload treatment system at delivery point.
3. Any require piping to connected the well to the treatment system or from the discharge side of the treatment system.
4. Electrical disconnects, or electrical connections of the treatment and pumping system.
5. Filing fees, permits fees and/or taxes.
6. Concrete pad to set equipment on.
7. Evaporation pond for backwash waste purposes.
8. Water testing and chemical analysis as may be required.
9. Applicable taxes, permits, and filing fees.

Price

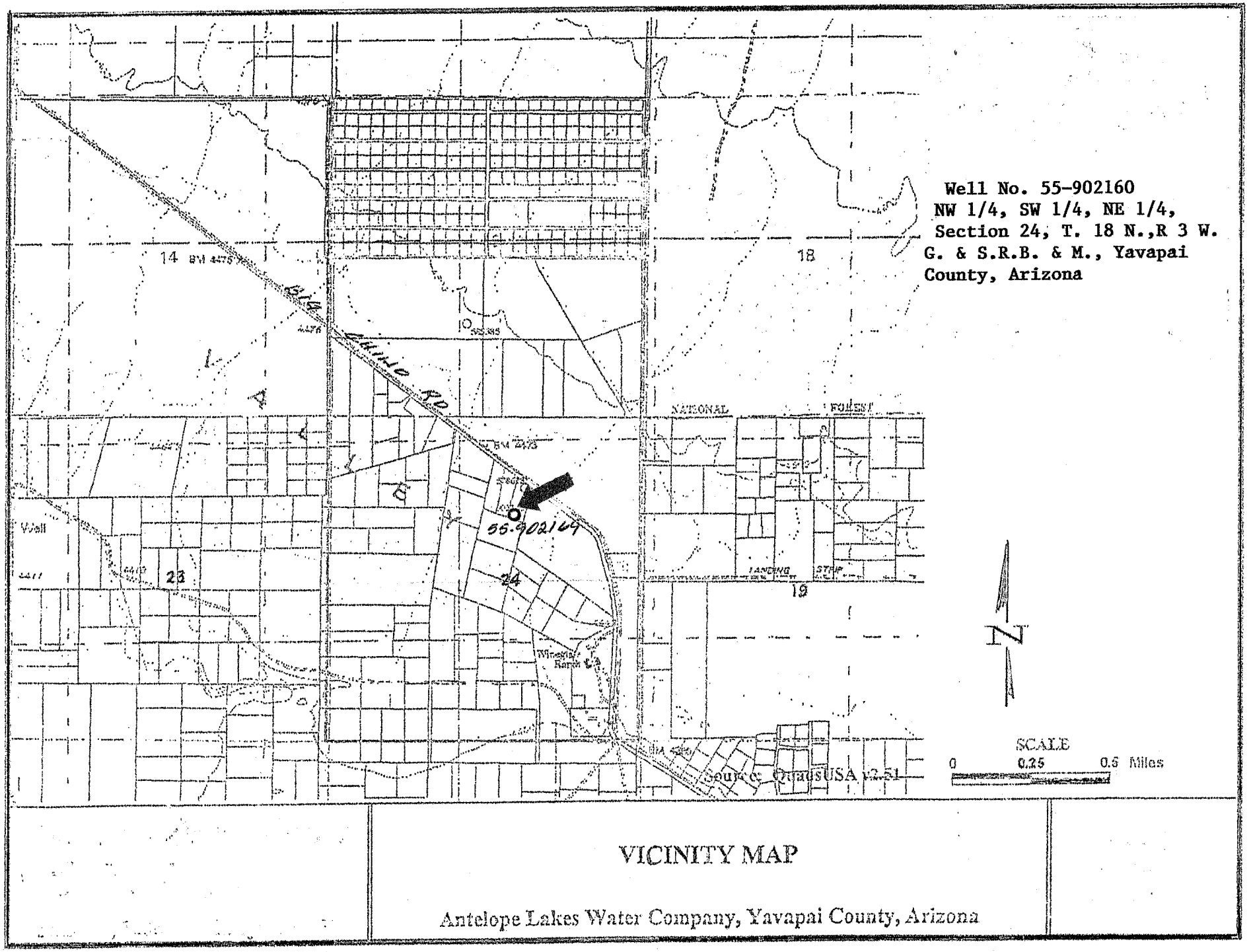
Total price for the above described treatment system and pumping station is **$120,500.**

Respectfully submitted:
Analytical Water Solutions, LLC

Maurice Lee Date: 1/15/07
Maurice Lee, Certified Operator and Manager

ATTACHMENTS


STATE OF
ARIZONA
SITE
UTAH
NEVADA
CALIFORNIA
NEW MEXICO
MEXICO
MOHAVE
COCONINO
NAVAJO
APACHE
YAVAPAI
LA PAZ
GILA
MARICOPA
GRAHAM
GREENLEE
YUMA
PINAL
PIMA
COCHISE
SANTA CRUZ
PHOENIX
Flagstaff
Prescott
Kingman
Tucson
Yuma
Paulden
Chino Valley
Ash Fork
Williams
Sedona
Lake Havasu City
Holbrook
Globe
Florence
Nogales
Bisbee
St. Johns
Safford
Clifton
Parker
LEGEND
PHOENIX STATE CAPITOL
Florence COUNTY SEAT
Tempe 50,000+ POP.
Douglas 10,000-50,000 POP.
El Mirage 5,000-10,000 POP.
Clifton 1,000-5,000 POP.
Alpine UNDER 1,000 POP.
Pearce SITE OR SETTLEMENT
LAKES & RIVERS
Meteor Crater POINTS OF INTEREST
INTERSTATE ROUTES
U.S. ROUTES
STATE ROUTES
INDIAN ROUTES
INTERNATIONAL BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
METROPOLITAN AREAS
SCALE
30 miles
50 kilometers
PHOENIX MAPPING SERVICE
division of Wide World of Maps, Inc.
www.maps4u.com
COPYRIGHT © 2006 WIDE WORLD OF MAPS, INC.
All rights reserved. It is illegal to copy or reproduce this map by any method, in whole or in part, regardless of purpose, without the authorization of Wide World of Maps, Inc.
ITEM NO. 76812



VICINITY MAP

Antelope Lakes Water Company, Yavapai County, Arizona

Chino Meadows II Water Company	Project: 2006 New Source	
P.O. Box 350	Project Number: Wineglass Well (55-902169)	Reported:
Chino Valley, AZ 86323	Project Manager: Dewey Levie	03/03/06 14:39

Wine Glass Well (Paulden) (6020410-01) Drinking Water () Sampled: 02/07/06 09:30 Received: 02/08/06 09:35

Analyte	Result	RL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Radiation Safety Engineering #AZ0462									
Calculation									
Combined Radium	<0.3		pCi/L	1	NA		02/16/03 00:00	Calculation	
EPA 600/00-02									
Adjusted Gross Alpha	4.8 +/- 4.7		pCi/L	1	NA		02/13/06 00:00	EPA 600/00-02	
Gross Alpha Activity	50.4 +/- 4.4		pCi/L	1	NA		02/13/06 00:00	EPA 600/00-02	
EPA 903.1									
Radium 226 Activity	<0.2		pCi/L	1	NA		02/16/03 00:00	EPA 903.1	
EPA 904.0									
Radium 228 Activity	<0.3		pCi/L	1	NA		02/16/03 00:00	EPA 904.0	
Pace Analytical Services #AZ0014									
EPA 1613B									
Dioxin	<0.000000005	0.000000005	mg/L	1	N/A	02/10/06 00:00	02/14/06 00:00	EPA 1613B	
Microbiology									
Total Coliforms	Absent		P/A	1	B6B0233	02/08/06 13:40	02/08/06 13:40	SM 9223B	
E. coli	Absent		P/A	1	B6B0233	02/08/06 13:40	02/08/06 13:40	SM 9223B	
Total Metals									
Antimony	<0.004	0.004	mg/L	1	B6B0327	02/10/06 17:00	02/16/06 07:09	EPA 200.9	
Arsenic	2.17	0.200	mg/L	1	B6B0326	02/10/06 17:00	02/13/06 16:22	EPA 200.7	
Barium	0.03	0.01	mg/L	1	B6B0326	02/10/06 17:00	02/16/06 00:00	EPA 200.7	
Beryllium	<0.002	0.002	mg/L	1	B6B0326	02/10/06 17:00	02/13/06 16:22	EPA 200.7	
Cadmium	<0.0002	0.0002	mg/L	1	B6B0327	02/10/06 17:00	02/14/06 11:36	EPA 200.9	
Calcium	2	1	mg/L	1	B6B0326	02/10/06 17:00	02/16/06 00:00	EPA 200.7	
Chromium	<0.005	0.005	mg/L	1	B6B0326	02/10/06 17:00	02/13/06 16:22	EPA 200.7	
Copper	0.01	0.01	mg/L	1	B6B0326	02/10/06 17:00	02/13/06 16:22	EPA 200.7	
Lead	0.007	0.002	mg/L	1	B6B0327	02/10/06 17:00	02/14/06 11:36	EPA 200.9	
Magnesium	<1	1	mg/L	1	B6B0326	02/10/06 17:00	02/23/06 00:00	EPA 200.7	
Mercury	<0.0002	0.0002	mg/L	1	B6B0227	02/10/06 09:00	02/13/06 09:31	EPA 245.1	
Nickel	<0.02	0.02	mg/L	1	B6B0326	02/10/06 17:00	02/13/06 16:22	EPA 200.7	
Selenium	<0.002	0.002	mg/L	1	B6B0327	02/10/06 17:00	02/14/06 11:36	EPA 200.9	
Sodium	668	10	mg/L	10	B6B0326	02/10/06 17:00	02/20/06 00:00	EPA 200.7	
Thallium	<0.001	0.001	mg/L	1	B6B0327	02/10/06 17:00	03/01/06 16:59	EPA 200.9	
Calcium Hardness	5	2	mg/L	1	[CALC]	02/10/06 17:00	02/16/06 00:00	SM 2340B	
Magnesium Hardness	<4	4	mg/L	1	[CALC]	02/10/06 17:00	02/23/06 00:00	SM 2340B	
Total Hardness	<7	7	mg/L	1	[CALC]	02/10/06 17:00	02/23/06 00:00	SM 2340B	

Chino Meadows II Water Company	Project: 2006 New Source	
P.O. Box 350	Project Number: Wineglass Well (55-902169)	Reported:
Chino Valley, AZ 86323	Project Manager: Dewey Levie	03/03/06 14:39

Wine Glass Well (Paulden) (6020410-01) Drinking Water () Sampled: 02/07/06 09:30 Received: 02/08/06 09:35

Analyte	Result	RL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity [(as CaCO3)]	1390	10	mg/L	1	B6B0457	02/15/06 14:30	02/15/06 17:59	SM 2320 B	M2
Cyanide, Total	<0.0097	0.0097	mg/L	1	B6B0241	02/09/06 16:15	02/09/06 16:15	SM 4500 CN E	
Fluoride	9.32	0.20	mg/L	1	B6B0352	02/13/06 18:30	02/13/06 18:30	SM 4500 F C	
Nitrate as N	0.11	0.10	mg/L	1	[CALC]	02/13/06 09:28	02/13/06 09:32	Calculation	
Nitrate + Nitrite	0.11	0.10	mg/L	1	B6B0322	02/13/06 09:28	02/13/06 09:32	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B6B0205	02/08/06 17:00	02/08/06 17:00	SM 4500 NO2 B	
pH	9.6		pH Units	1	B6B0207	02/08/06 07:30	02/08/06 07:30	EPA 150.1	
Temperature	14.7		°C	1	B6B0207	02/08/06 07:30	02/08/06 07:30	pH Temperature	
Total Dissolved Solids	1580	1	mg/L	1	B6B0283	02/10/06 12:30	02/10/06 12:30	SM 2540 C	
Miscellaneous									
Langlier Index	0.940	-5.00	N/A	1	B6B0020	02/08/06 00:00	02/20/06 00:00	Miscellaneous	
Herbicides									
Glyphosate	<0.006	0.006	mg/L	1	B6B0214	02/08/06 16:00	02/08/06 17:16	EPA 547	
Fiberquant Analytical Services #AZ0633									
EPA 100.1									
Asbestos	<1.	1.	MFL	1	N/A	02/08/06 00:00	02/16/06 00:00	EPA 100.1	
Del Mar Analytical - Phoenix									
INORGANICS									
Sulfate [SO4]	60	5.0	mg/l	10	P6B1610	02/16/06 16:07	02/16/06 17:15	EPA 300.0	

Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

Aerotech Environmental — Analytical Report — Date: *30-Mar-06*

CLIENT:	Analytical Water Solutions LLC	**Client Sample ID:**	1 Gallon
Lab Order:	06031605	**Tag Number:**	
Project:	Chino Meadows	**Collection Date:**	2/7/2006 11:00:00 AM
Lab ID:	06031605-01A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY ION CHROMATOGRAPHY		**E300**				Analyst: **LB**
Chloride	19	2.0		mg/L	1	3/29/2006 12:50:00 AM
Fluoride	8.8	0.40		mg/L	1	3/29/2006 12:50:00 AM
Sulfate	57	2.0		mg/L	1	3/28/2006 1:02:00 PM
PH (3)		**M4500-H+**				Analyst: **T S**
pH	9.5	2.00		S.U.	1	3/27/2006 5:40:00 PM
Temperature - °C	19.9	0		°C	1	3/27/2006 5:40:00 PM
RESIDUE, FILTERABLE		**M2540 C**				Analyst: **LMc**
Total Dissolved Solids	1600	10	H3,N1	mg/L	1	3/27/2006

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.

(1) AEL - Tucson Laboratory

(2) AEL - Knudsen Laboratory

(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803
Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

Aerotech Environmental — Analytical Report — Date: *30-Mar-06*

CLIENT:	Analytical Water Solutions LLC	**Client Sample ID:**	1 Gallon
Lab Order:	06031605	**Tag Number:**	
Project:	Chino Meadows	**Collection Date:**	2/7/2006 11:00:00 AM
Lab ID:	06031605-01B	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ICP METALS, TOTAL RECOVERABLE		**E200.7**				Analyst: **TD**
Boron	40	0.20		mg/L	1	3/28/2006
Calcium	< 2.0	2.0		mg/L	1	3/28/2006
Hardness, Calcium/Magnesium (As	< 13	13		mg/L	1	3/28/2006
Magnesium	< 2.0	2.0		mg/L	1	3/28/2006
Silica (Silicon dioxide-SiO2)	26	0.21		mg/L	1	3/28/2006
ICP/MS METALS, TOTAL RECOVERABLE		**E200.8**				Analyst: **TD**
Arsenic	2.1	0.0010		mg/L	1	3/28/2006 12:15:49 PM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.

(1) AEL - Tucson Laboratory

(2) AEL - Knudsen Laboratory

(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803
Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

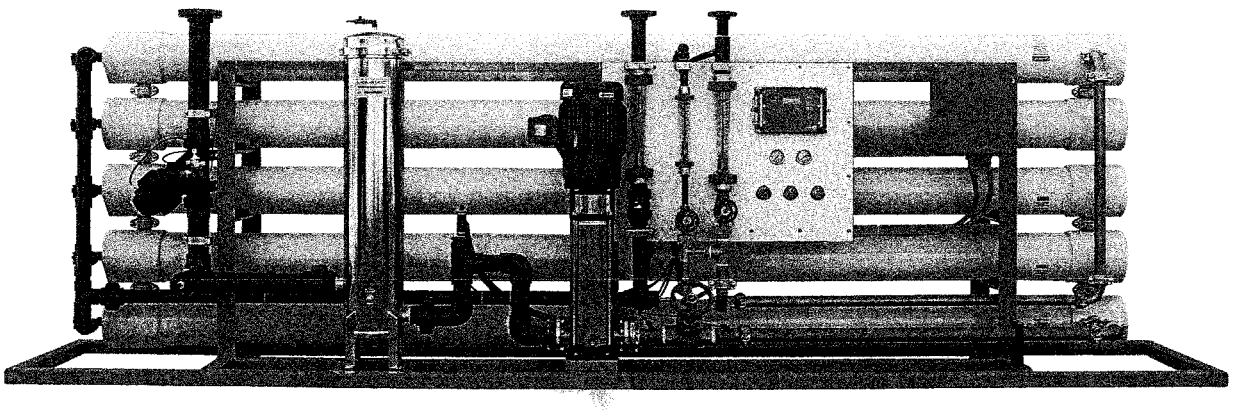
R48 Commercial RO Systems

We dare you to compare our R48 Commercial RO systems to other systems of similar size offered by our competition. Our systems are built to meet your flow requirements on startup and continue to meet that same requirement for years of service.

Our conservative design approach ensures that the RO membranes are operated according to the manufactures guidelines. This reduces the potential for membrane fouling that often occurs on systems with undersized pumps.

Standard Features

- Powder coated steel frame
- 316 SS Pre-filter pressure vessels
- Heavy-duty multi-stage centrifugal pump
- Automatic inlet valve
- Low-pressure shutdown with automatic restart
- Tank level input
- CI-2000 Electronic Controller with feed and product water conductivity meter, percent rejection, and alarm output
- Tank level input
- Pretreatment interlock input
- Adjustable reject recycle
- Prefilter pressure gauges
- Panel mounted liquid filled pressure gauges
- Product, reject, and reject recycle flow meters
- Product check valve
- Programmable concentrate flush (Auto Flush)



R48-20-3131100

Specifications and Ordering Information

	R48-08	R48-12	R48-16	R48-20
Maximum Productivity (gallons per minute)	40	60	80	100
Quality (typical membrane percent rejection)	98%			
Recovery (adjustable)	65% - 75%			
Membrane Size	8" x 40"			
Membrane Array (four elements per vessel)	1:1	2:1	2:2	3:2
Prefilter (system ships with five micron cartridges)	7 round x 30"		7 round x 40"	
Feed Water Connection	2" Flange	2.5" Flange	3" Flange	
Product Water Connection	2" Flange		2.5" Flange	
Reject Water Connection	1.5" Flange			
Feed Water Required (GPM at 65% recovery)	62	93	123	154
Minimum Feed Water Pressure	20 PSIG	20 PSIG	20 PSIG	20 PSIG
Drain Required (maximum gpm)	62	93	123	154
460 VAC, 3-phase, 60Hz (other voltages available)	25 amps	30 amps	35 amps	40 amps
Motor Horse Power (TEFC Motor)	15	20	25	30
Dimensions L x W x H (approximate)	186" x 26" x 72"			
Shipping Weight (estimated pounds)	2500	2800	3200	3500

Part Number	Description
R48-08-3131100	40 gpm unit with CI-2000 electronic controller
R48-12-3131100	60 gpm unit with CI-2000 electronic controller
R48-16-3131100	80 gpm unit with CI-2000 electronic controller
R48-20-3131100	100 gpm unit with CI-2000 electronic controller

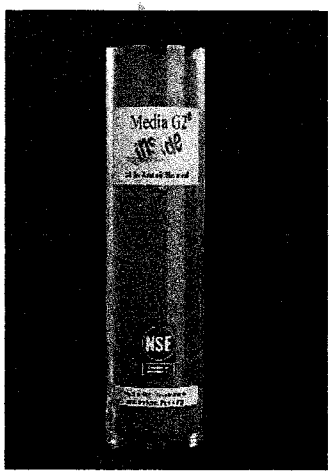
Notes:

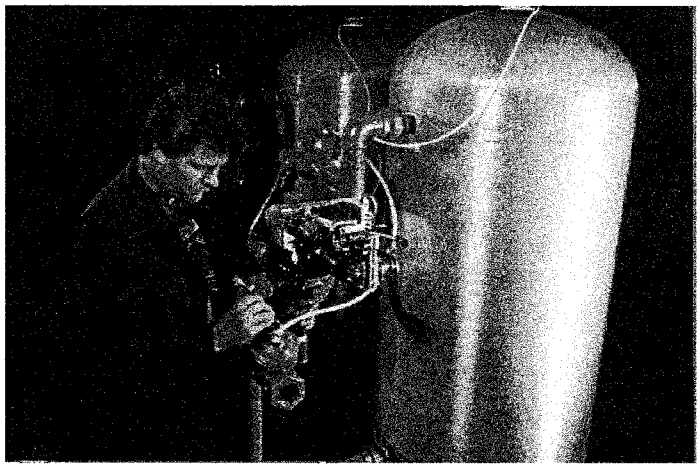
- Maximum production based on a feed water of 77° F, SDI < 3, 1000 ppm TDS, and pH 7.6. Individual membrane productivity may vary (± 15%). May be operated on other feed waters with reduced capacity.
- Percent Rejection is based on membrane manufactures specifications; overall system percent rejection may be less.
- Specifications subject to change.

There is an Alamo Brand® RO System for every need.

Manufactured by: **Alamo Water Refiners, Inc.**, San Antonio, Texas

DISTRIBUTED BY:





ADI INTERNATIONAL INC.
MEDIA G2® Technology Description

ADI International Inc.
Phone: 1-800-858-1888
Fax: 506-459-3954
Email: mjm@adi.ca

MEDIA G2®is an iron-based adsorption treatment technology for removing arsenic from water, specifically groundwater, for potable use. The technology involves adsorption of arsenic onto a filter media (MEDIA G2®) as water passes through it. MEDIA G2® adsorption media consists of granular, calcined diatomite upon which ferric hydroxide is chemically bonded. Iron attracts the arsenic in water and binds it to the substrate by chemisorption. Although it was developed specifically for adsorbing arsenic, MEDIA G2® will also adsorb iron, manganese, uranium and chromium. The adsorption capacity for arsenic is in the range of about 800 to 2400 μg/g, depending on operating pH and other contaminants in the water.

Research, pilot tests, and full-scale operating history, have shown that MEDIA G2® systems work well in the pH range of 5.5 to 7.5 - the lower the pH the better for extending the life of the media; i.e., its adsorption capacity increases with decreasing pH. However, for most applications, it is desired to operate the system in the 6.5 to 7.0 pH range.

An arsenic removal system consists of one or more pressure vessels containing MEDIA G2® adsorption media, operated in a down-flow mode. Most systems are sized for 10 minutes EBCT (Empty Bed Contact Time). The media depth is about three feet (one metre), which results in a filtration rate of about 2.5 to 3.0 gpm/ft^2 (5 to 7 m/s) when the EBCT is 10 minutes. The vessels can be operated in series or in parallel. The hydraulic capacity of a system is determined by the size and number of vessels.

As the media becomes saturated with arsenic, the concentration in the treated water begins to increase. Before this concentration reaches the maximum allowable contaminant level (break through), the media is either replaced or regenerated in-situ. MEDIA G2® adsorption media can be regenerated 4 to 5 times, in-situ, in a process which takes only a few hours. The volume of waste produced in regeneration is typically less than 0.1% of the volume of treated water. The adsorption capacity of the media is reduced by 10% with each regeneration; therefore, after 4 - 5 regenerations, it is more economical and practical to replace the media. Of significance is the fact that the residuals generated from regeneration, as well as the spent media itself, are non-hazardous according to US EPA's TCLP and Canadian Reg 347.

Physical Properties

Density: 47 lb/ft^3 (753 kg/m^3)
Hardness: 210 lb/in^2 (14.8 kg/cm^2)
Effective size: 0.32 mm
Uniformity Coefficient: 1.8 - 2.0
Fe percent by weight 5% to 30%

Bulk Relative Density: 1.073
Bulk Relative Density (SSD): 1.618
Apparent Relative Density: 2.359
Adsorption, %: 51.1

Other Properties & Features

Adsorbs both As III and As V
Little interference from chlorides and sulfates up to 500 mg/L
Maximum iron concentration in raw water - 2.0 mg/L
Maximum manganese concentration in raw water - 0.8 mg/L

Certified to ANSI/NSF Standard 61

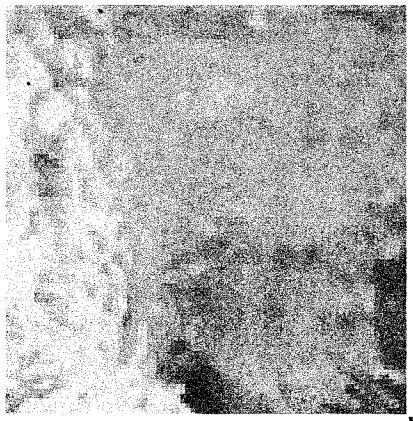
Performance verified by ETV Canada Inc.

NSF
Certified to ANSI/NSF-61

CANADA VERIFIED VÉRIFIÉ
Performance Claim Verified by the ETV Program

MEDIA G2® is a registered Trade Mark of ADI International Inc. 1133 Regent Street, Suite 300, Fredericton, NB E3B 3Z2 Canada. Contact: Eric Winchester
Tel: 506-451-7407; Email: elw@adi.ca , or
Michael McMullin
Tel: 506-451-7423; Email: mjm@adi.ca

US Patent No. 6,200,482, other related patents pending.

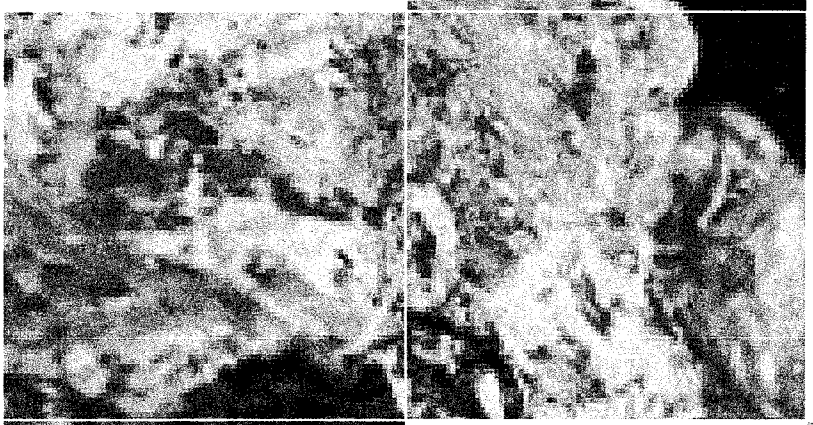


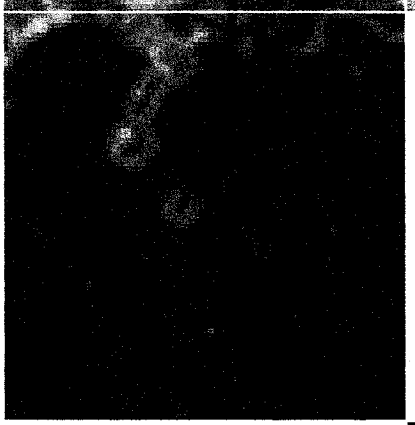
Actiguard AAFS50

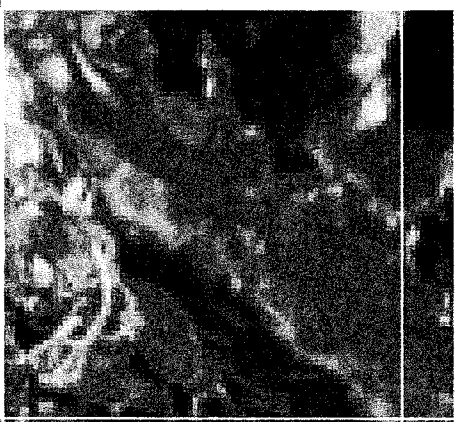
Arsenic Removal

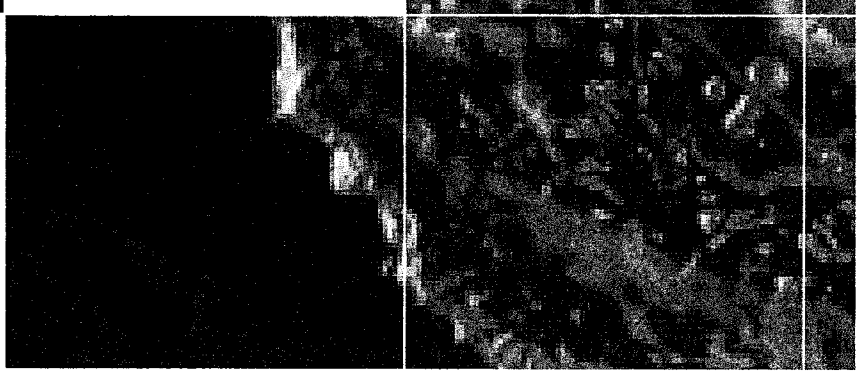
The right choice to achieve less than five ppb of arsenic.

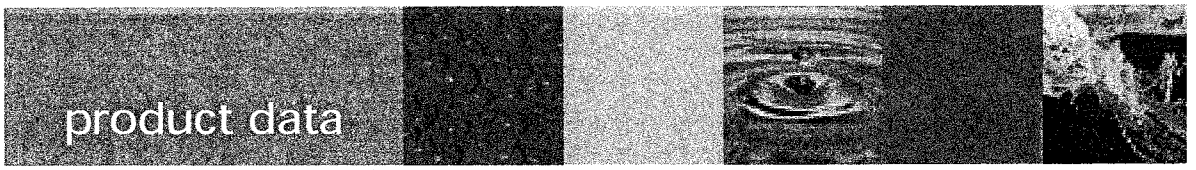
- Simple Design: flow-through unit with 5-8 minute dwell time.
- Low Cost Media: economical per-unit cost.
- No Disposal Concerns: spent material is TCLP approved and landfillable.
- No Pressure Drop: granular material will not degrade over time, causing pressure drop.
- Commercially Available: produced in large scale North American production facility, owned by one of the largest aluminum companies in the world.
- Certified to ANSI NSF61.











Actiguard AAFS50

Activated Aluminas

Alcan Specialty Aluminas' ActiGuard AAFS50 Activated Alumina is specifically designed to remove arsenic from potable water.

ActiGuard AAFS50 is activated alumina promoted with a proprietary additive. This combination has been engineered for enhanced arsenic removal from water. AAFS50 has shown arsenic capacities of two to three times greater than unpromoted activated alumina.

Arsenic commonly occurs in two forms: As(V) (arsenate) and As(III) (arsenite). Maximum arsenic capacity is achieved when dealing with As(V).

AAFS50's capacity for As(III) adsorption is about 40% its capacity for As(V). Oxidation is recommended to assist with As(III) removal, when possible. Simple chlorination will oxidize As(III) to As(V) allowing complete removal.

ActiGuard AAFS50 can be effective at a wide range of pH levels depending on the competing ions present. Where high levels of silica are present, along with a pH level higher than 7.0, an adjustment may be necessary for optimum results.

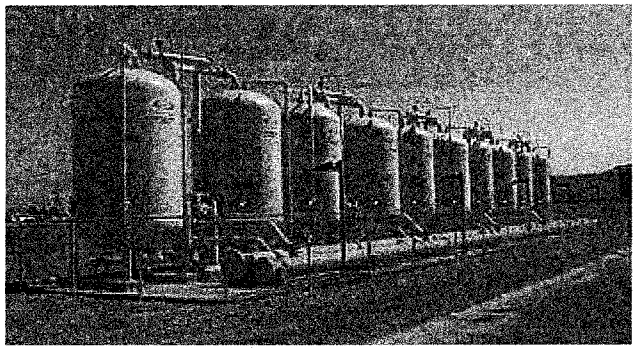
The performance of any adsorbent is dependent on the water being treated. The data provided is for guideline purposes only. Users are advised to check performance prior to their adoption into a system.

Available in granular form in sizes 28 x 48 mesh, with other sizes being supplied on special request.

Packaged in 907 kg (2,000 lb.) super bags, 158 kg (350 lb.), 45 kg (100 lb.), and 22 kg (50 lb.) boxes. Other forms of packaging can be considered on special request.

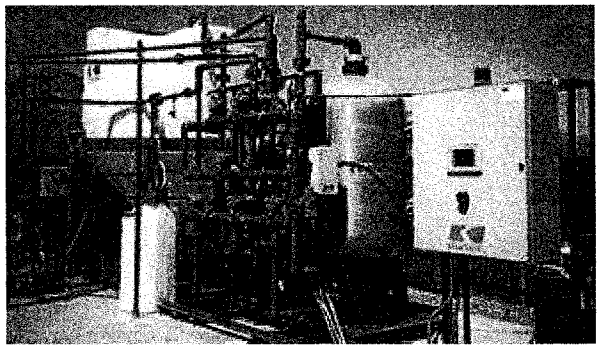
Certified to ANSI NSF61.

Passed U.S. EPA TCLP (Total Characteristic Leaching Procedure)



CHEMICAL ANALYSIS of ActiGuard AAFS50

Constituents	Weight %
Al_2O_3 + proprietary additive	75
Loss on Ignition	25



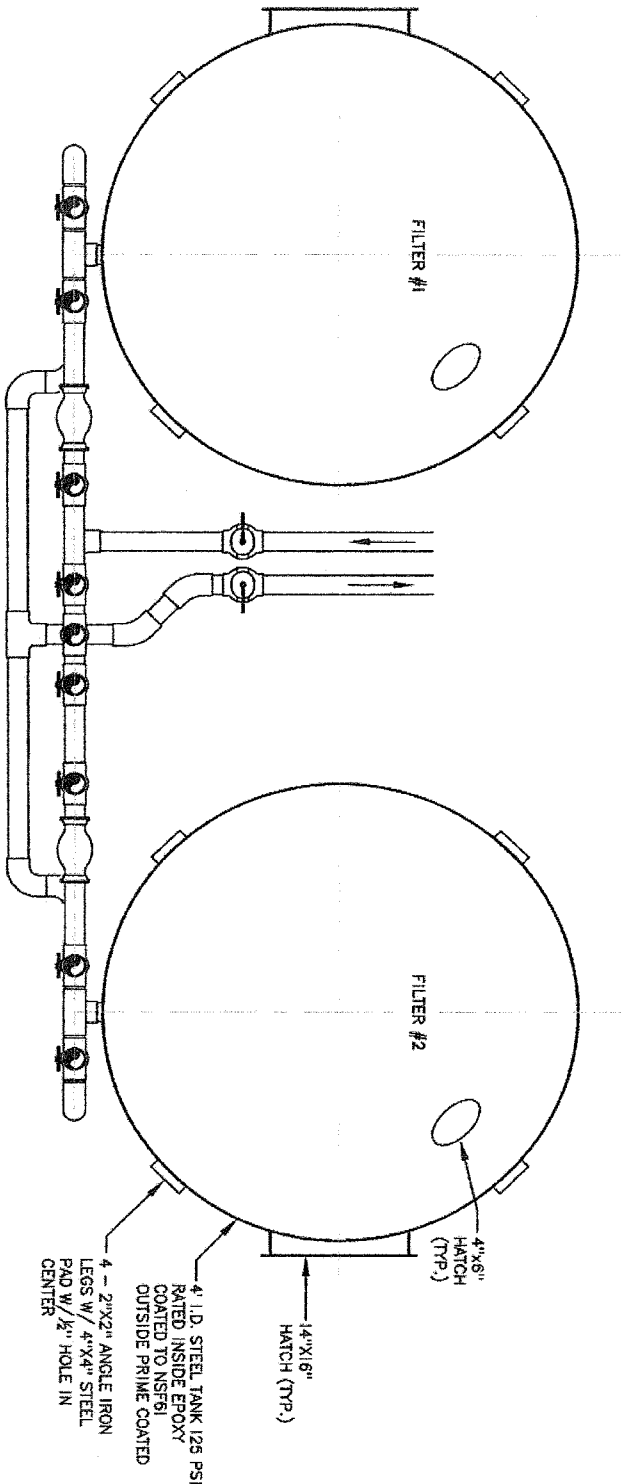
ALCAN BAUXITE & ALUMINA

ALCAN SPECIALTY ALUMINAS
Alcan Inc.
International Sales Brockville
4000 Development Drive
Brockville, ON K6V 5V5
Telephone: 613-342-7462
Fax: 613-342-6943

ALCAN SPECIATLY ALUMINAS
Alcan Aluminum Corporation
US Sales Cleveland
6060 ParklandBlvd
Cleveland, OH 44124-4185
Telephone: 440-423-6309
Fax: 440-423-6312
Toll Free: 800-321-3864

ALCAN SPECIATLY ALUMINAS
Alcan Inc.
Canadian Sales Brockville
4000 Development Drive
Brockville, ON K6V 5V5
Telephone: 613-342-7462
Fax: 613-342-6943

ALCAN
imagination materialized



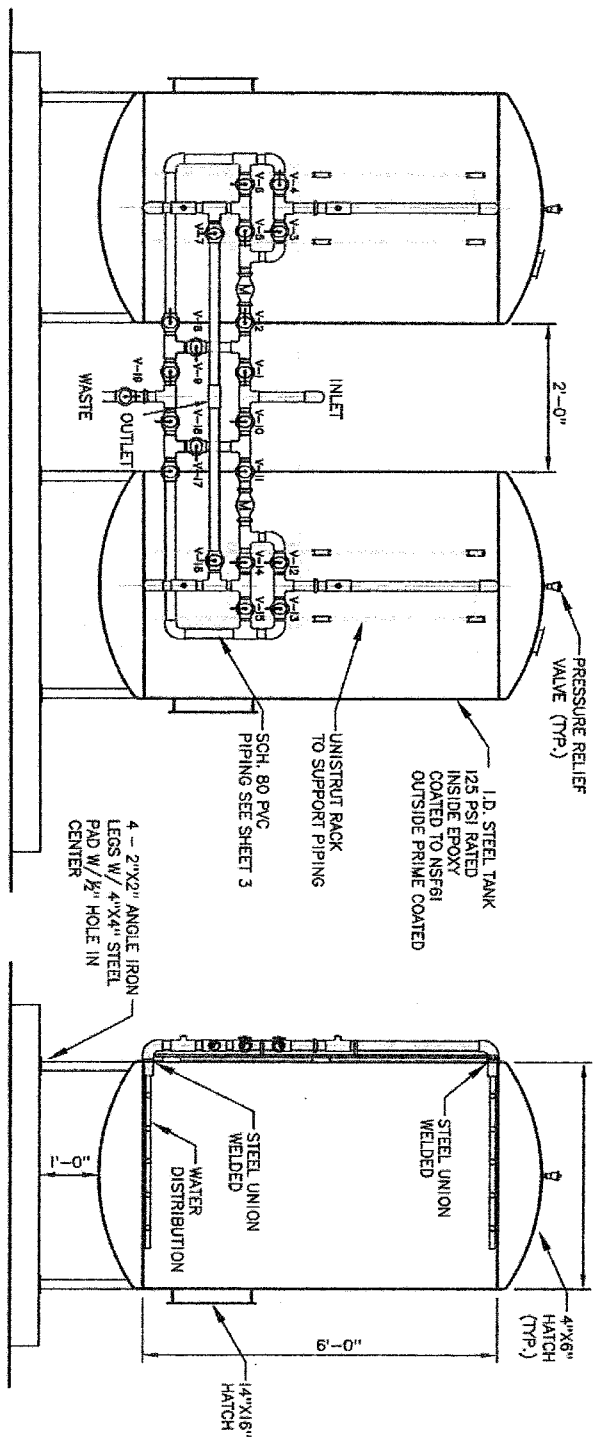
ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983

DESIGNED	ML	SCALE: 1"=1'
DRAWN	TD	DATE: 7/10/06
CHECKED	ML	

NO.	REVISIONS

DOUBLE FILTER
PLAN VIEW

SHEET 1 OF 6



SHEET 2 OF 6

ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983

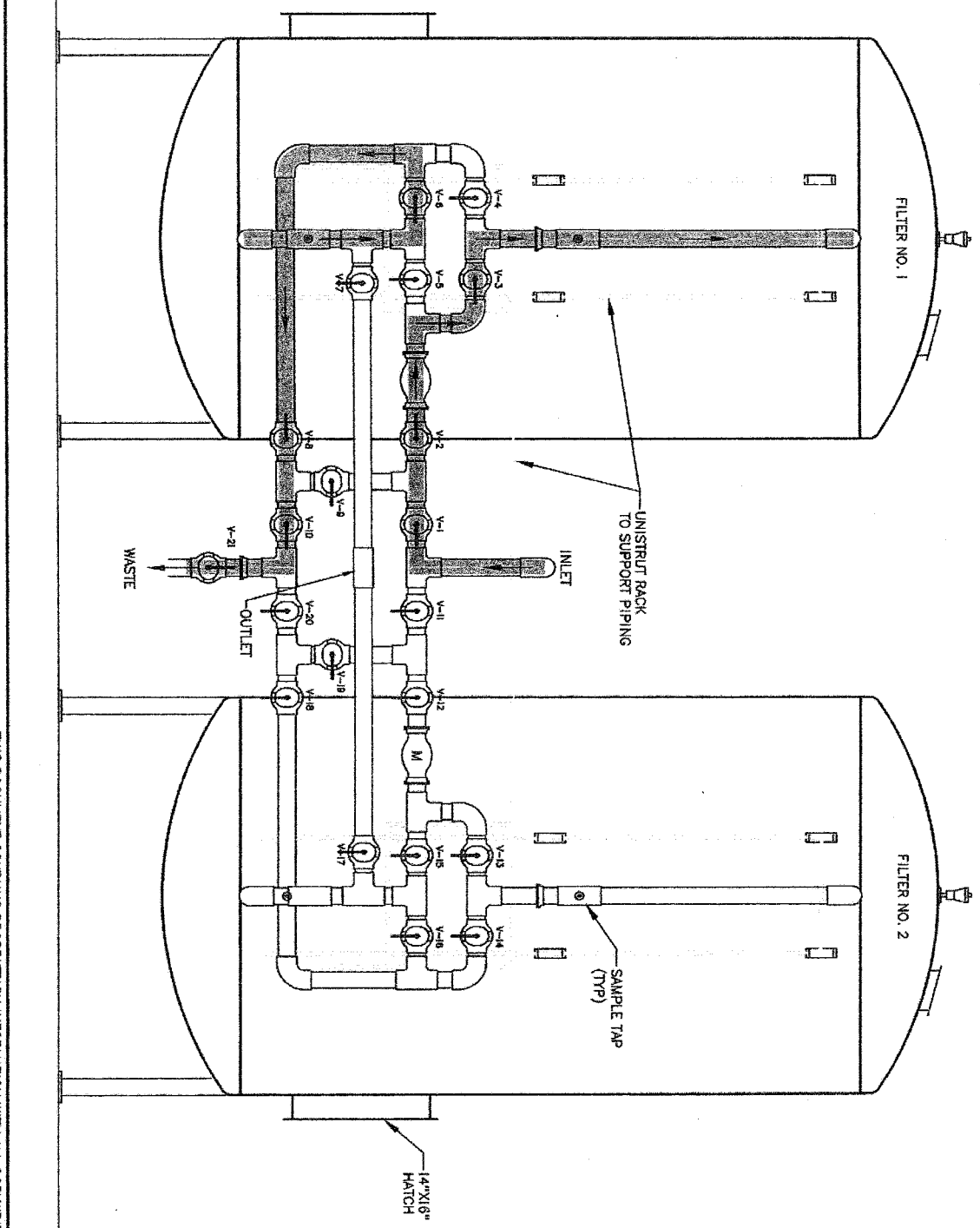
DESIGNED	ML	SCALE: 1"=1'
DRAWN	TD	DATE: 7/10/06
CHECKED	ML	

NO.	REVISIONS	DATE

DOUBLE FILTER VERTICAL ARRANGEMENT

ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983
DESIGNED ML
DRAWN TD
CHECKED ML
SCALE: 1"=1'
DATE: 7/10/06
NO. REVISIONS DATE
LEAD/LAG ARRANGEMENT
VALVING & DETAIL
SHEET 3 OF 6
14"X16" HATCH
SAMPLE TAP (TYP)
FILTER NO. 2 LAG
FILTER NO. 1 LEAD
UNISTRUT RACK TO SUPPORT PIPING
INLET
OUTLET
WASTE
V-1
V-2
V-3
V-4
V-5
V-6
V-7
V-8
V-9
V-10
V-11
V-12
V-13
V-14
V-15
V-16
V-17
V-18
V-19
V-20
V-21
LEAD/LAG ARRANGEMENT
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WITH ALL COPYWRITES AND TITLES RESERVED AND MAY NOT BE REPRODUCED IN WHOLE OR IN PART WITHOUT THE WRITTEN CONCENT OF ANALYTICAL WATER SOLUTIONS, LLC

ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983
DESIGNED ML
DRAWN TD
CHECKED ML
SCALE: 1"=1'
DATE: 7/10/06
NO. REVISIONS DATE
PARALLEL FLOW
VALVING & DETAIL
SHEET 4 OF 6
14"X16" HATCH
SAMPLE TAP (TYP)
FILTER NO. 2
FILTER NO. 1
INLET
OUTLET
WASTE
UNISTRUT RACK TO SUPPORT PIPING
V-1
V-2
V-3
V-4
V-5
V-6
V-7
V-8
V-9
V-10
V-11
V-12
V-13
V-14
V-15
V-16
V-17
V-18
V-19
V-20
V-21
PARALLEL FLOW
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WITH ALL COPYWRITES AND TITLES RESERVED AND MAY NOT BE REPRODUCED IN WHOLE OR IN PART WITHOUT THE WRITTEN CONCENT OF ANALYTICAL WATER SOLUTIONS, LLC



RINSE ARRANGEMENT FILTER NO. 1

SHEET 5 OF 6

ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983

DESIGNED	ML	SCALE: 1"=1'
DRAWN	TD	DATE: 7/10/06
CHECKED	ML	

NO.	REVISIONS	DATE

RINSE ARRANGEMENT VALVING & DETAIL

ANALYTICAL WATER SOLUTIONS, LLC
P.O. BOX 30543 PHOENIX, ARIZONA 85046-0543
PH. (602) 795-7980 FAX. (602) 795-7983
DESIGNED ML
DRAWN TD
CHECKED ML
SCALE: 1"=1'
DATE: 7/10/06
NO. REVISIONS DATE
BACKWASH & DETAIL VALVING
SHEET 6 OF 6
BACKWASH FILTER NO. 1
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WITH ALL COPYWRITES AND TITLES RESERVED AND MAY NOT BE REPRODUCED IN WHOLE OR IN PART WITHOUT THE WRITTEN CONCENT OF ANALYTICAL WATER SOLUTIONS, LLC
14"X16" HATCH
SAMPLE TAP (TYP)
FILTER NO. 2
FILTER NO. 1
UNISTRUT RACK TO SUPPORT PIPING
INLET
OUTLET
WASTE
V-1
V-2
V-3
V-4
V-5
V-6
V-7
V-8
V-9
V-10
V-11
V-12
V-13
V-14
V-15
V-16
V-17
V-18
V-19
V-20
V-21

ETV JOINT VERIFICATION STATEMENTS

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC ADSORPTION MEDIA FILTER USED IN DRINKING WATER TREATMENT SYSTEMS**	
APPLICATION:	**REMOVAL OF ARSENIC IN DRINKING WATER**	
TECHNOLOGY NAME:	**ADI PILOT TEST UNIT NO. 2002-09 WITH MEDIA G2®**	
COMPANY:	**ADI INTERNATIONAL INC.**	
ADDRESS:	**SUITE 300** **1133 REGENT STREET** **FREDERICTON, NB E3B 3Z2 CANADA**	PHONE: **(506) 452-9000** FAX: **(506) 459-3954**
WEB SITE:	**www.adi.ca**	
EMAIL:	**mjm@adi.ca**	

The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

NSF International (NSF), in cooperation with the EPA, operates the Drinking Water Systems (DWS) Center, one of seven technology areas under the ETV Program. The DWS Center recently evaluated the performance of an adsorption media filter system for the reduction of arsenic in drinking water. This verification statement provides a summary of the test results for the ADI Pilot Test Unit No. 2002-09 with MEDIA G2® system. Gannett Fleming, Inc., an NSF-qualified field testing organization (FTO), performed the verification testing. The verification report contains a comprehensive summary of the verification test.

ABSTRACT

Verification testing of the ADI International Inc. Pilot Test Unit No. 2002-09 with MEDIA G2® arsenic adsorption media filter system was conducted at the Hilltown Township Water and Sewer Authority (HTWSA) Well Station No. 1 in Sellersville, Pennsylvania from October 8, 2003 through May 28, 2004. The source water was groundwater from Well No. 1, one of HTWSA's three groundwater supply wells. The treatment unit feed water for the verification test was withdrawn from an on-site chlorine detention tank, which contained groundwater that had been disinfected with sodium hypochlorite. Verification testing was conducted under manufacturer-specified operating conditions. The feed water, with an average total arsenic concentration of 21 µg/L and a pH of 7.6, was treated with sulfuric acid to lower the pH to 6.4 prior to the treatment unit. When operated under the manufacturer's specified conditions for this site and at the design flow rate of 1.7 gpm, the ADI International Inc. Pilot Test Unit No. 2002-09 with MEDIA G2® system reduced the total arsenic concentration from an average of 21 µg/L in the feed water to an average of 7 µg/L in the treated water.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

MEDIA G2® is an iron-based adsorption treatment technology for removing arsenic from drinking water supplies, specifically groundwater. MEDIA G2® arsenic adsorption media consists of an inorganic, natural substrate to which iron (ferric hydroxide) has been chemically bonded. The iron attracts metallic ions in water and binds them to the substrate by chemisorption. The arsenic adsorption filter pilot unit used in this test consisted of one vessel containing MEDIA G2® adsorption media which was operated in a downflow mode. Arsenic is removed by the technology by adsorption onto the filter media as water passes through the media. Over time, as the media becomes saturated with arsenic, the concentration of arsenic in the treated water begins to increase. Before the treated water arsenic concentration reaches the pre-determined maximum allowable contaminant level (breakthrough), the media is either replaced or regenerated on-site. ADI has stated that MEDIA G2® can be regenerated four to five times, with a loss in capacity of approximately 10% following each regeneration.

MEDIA G2® is a registered trade mark of ADI International Inc. and is protected by US Patent No. 6,200,482. MEDIA G2® adsorption media is certified under NSF/ANSI Standard 61 for water treatment plant applications. MEDIA G2® treatment units can be used for groundwater supplies of any size and require limited manpower and operating skills. The filter system can operate continuously or intermittently. The filter tank is freestanding, and filter components, which are modular in nature, can be installed by a qualified plumber. The filter system requires only a level surface capable of supporting its weight, sustained ambient temperature above 35°F, a feed water pressure between 20 and 125 psi, and flow rate control.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was the HTWSA Well No. 1 in Sellersville, Pennsylvania. The source water was groundwater from Well No. 1, which was first disinfected with sodium hypochlorite. Well No. 1 is one of three wells currently used to supply the HTWSA water distribution system. The feed water quality was particularly variable for a groundwater supply. During the verification test, the turbidity ranged from 0.15 NTU to 7.6 NTU and averaged 0.70 NTU. The feed water iron concentration ranged from 47 µg/L to 1,120 µg/L and averaged 180 µg/L. The feed water manganese concentration ranged from 77 µg/L to 1,070 µg/L and averaged 140 µg/L. The feed water was characterized as having a high level of hardness,

270 mg/L as $CaCO_3$, and a high degree of buffering as indicated by an alkalinity of 120 mg/L as $CaCO_3$. The raw water pH was relatively stable at 7.6, but the feed water pH varied due to the operation of the acid feed pump. It ranged from 5.7 to 7.1, with an average of 6.4. The feed water total arsenic concentration ranged from 12 µg/L to 63 µg/L and averaged 21 µg/L.

Methods and Procedures

Operations, sampling, and analytical procedures were performed in a manner that ensured the quality of the data collected and provided an accurate evaluation of the treatment system under field conditions. The verification test consisted of three main phases. The first phase, the Integrity Test, evaluated the reliability of equipment operation under the environmental and hydraulic conditions at the well station site during the initial two weeks of testing. The second phase, the Capacity Test, evaluated the capacity of the arsenic adsorption system with respect to arsenic. The third phase of the test monitored the performance of the system for one month following regeneration.

The Integrity Test ran for 13 full days plus eight hours, during which the field test operator was on-site twice per day to monitor the test equipment, collect data, and collect water samples for analysis. The Capacity Test began in conjunction with the Integrity Test on October 8, 2003 and continued through the media regeneration on April 30, 2004. One month of post-regeneration operation began on April 30, 2004 and continued through May 28, 2004. The treatment system was operated continuously, independent of the well operations, using water supplied from the well station's pressurized chlorine detention tank. Flow rate, production volume, and pressure were monitored and recorded twice per day. Raw, feed (before and after addition of sulfuric acid), and treated water samples were analyzed for pH, temperature, turbidity, alkalinity, calcium, magnesium, hardness, free available chlorine, and fluoride by the field test operator. Samples were collected and delivered to the Pennsylvania Department of Environmental Protection Laboratory to be analyzed for silica, sodium, aluminum, iron, manganese, chloride, sulfate, and total phosphorus. Arsenic samples were collected and sent to NSF's laboratories for analysis. A total of 14 sets of arsenic samples were speciated during the test to determine the relative concentration of soluble arsenic compared to total arsenic, and, with respect to the soluble arsenic, the relative amounts of arsenic III and arsenic V.

Complete descriptions of the verification testing results and quality assurance/quality control procedures are included in the verification report.

VERIFICATION OF PERFORMANCE

System Operation

The verification test was conducted under the manufacturer's specified operating conditions. Contact time is a critical parameter for arsenic adsorption efficiency and is dependent upon maintaining the flow rate within the design range of 1.7 gpm ± 0.1 gpm. A pressure-reducing valve was used to reduce the pressure from the chlorine detention tank from 110 psi to 50 psi to make throttling the flow rate easier for the operator. A relatively constant flow rate was maintained, with minimal flow rate adjustments required. The system was operated continuously, 24 hours each day, for the entire test. The filter unit was manually backwashed and rinsed 15 times throughout the test, based on the accumulation of filter bed headloss.

Water Quality Results

The results of total arsenic analyses are shown in Figure VS-1. During the Capacity Test, the feed water total arsenic concentration averaged 21 µg/L, with 13 µg/L in the soluble state. Pretreatment with hypochlorite completely converted the feed water soluble arsenic to the arsenic V species. The treated

water total arsenic concentration averaged 7 µg/L during the Capacity Test, all of which was in the soluble state. For calculation of the media capacity to remove arsenic from the feed water, 430,000 gallons were treated from October 8, 2003 through April 22, 2004 during the Capacity Test. The treated water volume represents 25,000 media bed volumes, based on the calculated bed volume of 2.3 cubic feet and an empty bed contact time of ten minutes. Based on the feed and treated water total arsenic concentrations during the Capacity Test, the capacity of the media for this system, through April 22, 2004, was 470 µg arsenic per gram of media.

One media regeneration was performed during the verification test. As shown in Figure VS-1, treated water arsenic concentrations were elevated for several hours following the media regeneration. However, the post-regeneration treated water arsenic concentration (April 30, 2004 through May 28, 2004) returned to a level similar to that observed at the beginning of the Capacity Test, averaging 4 µg/L, which indicates that the media regeneration was successful.

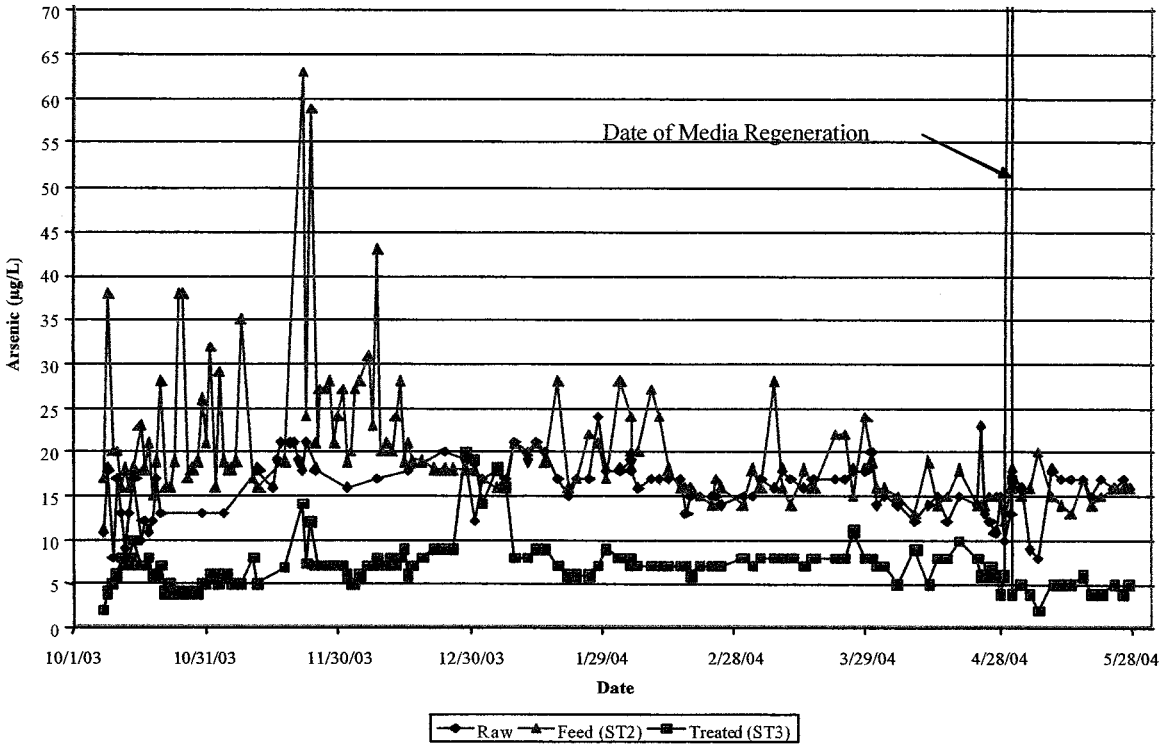


Figure VS-1. Capacity Test Arsenic Concentration.

The addition of sulfuric acid prior to the treatment unit reduced the pH of the raw water from an average of 7.6 to 6.4 in the feed water. The pH reduction corresponded with a 21% reduction in alkalinity. The sulfate concentration increased from an average of 100 mg/L in the raw water to 160 mg/L in the feed water, following the addition of sulfuric acid. The feed water pH appeared to have a significant impact on the treatment unit's ability to remove arsenic. The highest treated water arsenic concentrations occurred when the feed water pH was highest. The manufacturer indicated that the feed water pH should be maintained between 6.5 and 6.8 for optimum arsenic removal, but difficulties encountered with the acid feed pump operation resulted in several periods during the verification test when the pH was above this range. As an example of the correlation, a decrease in feed water pH from 7.1 to 6.2 on the ninth day of the test resulted in a 70% decrease in the treated water arsenic concentration. Thereafter, correlations in treated water arsenic with the feed water pH were not as significant but continued to occur. At the request

of the manufacturer, testing was carried out at reduced pH from April 23, 2004 through April 30, 2004. During the reduced pH operation, the treated water arsenic concentration averaged 6 µg/L.

Feed water calcium and hardness concentrations were reduced only slightly through the adsorption filter. The average feed water iron and manganese concentrations during the Capacity Test, 180 µg/L and 140 µg/L, respectively, were significantly reduced by the adsorption filter. The treated water iron concentration averaged 68 µg/L and the treated water manganese concentration averaged 16 µg/L. Turbidity was also reduced by the adsorption filter during the Capacity Test, from an average of 0.70 NTU in the feed water to 0.30 NTU in the treated water. The silica concentration increased by an average of 15%, from a feed concentration of 28 mg/L to a treated water concentration of 33 mg/L. Sodium, fluoride, chloride, aluminum, and sulfate concentrations were generally unaffected by the adsorption filter.

Operation and Maintenance Results

The verification test began on October 8, 2003 and ended on May 28, 2004. The treatment unit operated manually, including backwash cycles, throughout the test. The majority of operator time and attention was spent on water quality and equipment testing. Equipment operation required minimal operator attention overall, with the exception of the sulfuric acid metering pump, which required frequent re-priming and feed rate adjustment to maintain the feed water pH within the manufacturer's stated operating range. Periodic manual filter backwashes each required 1.5 to 2 hours of operator time, and media regeneration required approximately five hours. Fifteen manual filter backwashes and one media regeneration were performed during the verification test. The backwash water was relatively turbid and contained elevated concentrations of iron, manganese, aluminum, and arsenic. Arsenic in the backwash water was primarily in particulate form, which indicates the removal of particulate material from the filter, not desorption of arsenic from the media. The treated water arsenic concentration returned to approximately that of the new media following the media regeneration, which indicates a successful regeneration. However, a spike in the treated water arsenic concentration occurred when the unit was returned to service following the media regeneration. Modification of the media regeneration procedures and increased on-site monitoring of the treated water arsenic concentration may be required to prevent returning a unit to service with an elevated treated water arsenic concentration immediately following regeneration. Other than monitoring the metering pump and performing filter backwashes, regular operator attention was primarily required to verify, adjust, and maintain a constant flow rate.

Consumables and Waste Generation

Electrical power was required only for the metering pump and a solenoid valve. The solenoid valve was provided to automatically shut off the feed water supply in the event of a power outage to prevent water from entering the treatment unit without pH adjustments. Wastewater from each filter backwash and rinse was discharged to a sanitary sewer adjacent to the well station. The total water usage for each backwash and rinse was approximately 200 gallons, for a total backwash and rinse water usage of 2,800 gallons. The backwash and rinse water usage represents 0.5% of the total throughput of 520,000 gallons during the test, including the Integrity, Capacity, and post-regeneration phases.

The media regeneration, which was performed once during the verification test following seven months of operation, required three bed volumes (50 gallons) of 1% caustic soda, 20 gallons of 0.5% sulfuric acid solution, and rinse water.

Quality Assurance/Quality Control

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a

technical systems audit during the verification test to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

Original Signed by	*Original Signed by*
Sally Gutierrez *8/19/05*	*Robert Ferguson* *8/30/05*
Sally Gutierrez Date	Robert Ferguson Date
Director	Vice President
National Risk Management Research Laboratory	Water Systems
Office of Research and Development	NSF International
United States Environmental Protection Agency	

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and NSF make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end-user is solely responsible for complying with any and all applicable federal, state, and local requirements. Mention of corporate names, trade names, or commercial products does not constitute endorsement or recommendation for use of specific products. This report is not an NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents
Copies of the *ETV Protocol for Equipment Verification Testing for Arsenic Removal* dated April 2002, the verification statement, and the verification report (NSF Report #05/10/EPADWCTR) are available from the following sources:
(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy)

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC ADSORPTION MEDIA FILTER USED IN DRINKING WATER TREATMENT SYSTEMS**		
APPLICATION:	**REMOVAL OF ARSENIC IN DRINKING WATER**		
TECHNOLOGY NAME:	**PARA-FLO™ PF60 MODEL AAO8AS WITH ACTIGUARD AAFS50**		
COMPANY:	**KINETICO INC.**		
ADDRESS:	**10845 KINSMAN ROAD** **P.O. BOX 193** **NEWBURY, OH 44065**	PHONE: FAX:	**(440) 564-9111** **(440) 564-4222**
WEB SITE: EMAIL:	**http://www.kinetico.com** **mbrotman@kinetico.com**		
COMPANY:	**ALCAN CHEMICALS**		
ADDRESS:	**525 S. WASHINGTON STREET** **SUITE NO. 9** **NAPERVILLE, IL 60540-6641**	PHONE: FAX:	**(630) 527-1213** **(630) 527-1229**
WEB SITE: EMAIL:	**http://www.alcan.com** **bill.reid@alcan.com**		

The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholders groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

NSF International (NSF), in cooperation with the EPA, operates the Drinking Water Systems (DWS) Center, one of seven technology areas under the ETV Program. The DWS Center recently evaluated the performance of an adsorption media filter technology for the reduction of arsenic in drinking water. This verification statement provides a summary of the test results for the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 System. Gannett Fleming, Inc., an NSF-qualified field testing organization (FTO), performed the verification testing. The verification report contains a comprehensive description of the test.

ABSTRACT

Verification testing of the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 arsenic adsorption media filter system was conducted at the Orchard Hills Mobile Home Park (MHP) Water Treatment Plant (WTP) in Carroll Township, Pennsylvania from April 22, 2003 through October 28, 2003. The source water was untreated groundwater from one of the MHP's groundwater supply wells. The source water, with an average total arsenic concentration of 14 µg/L and a pH of 7.6, received no treatment or chemical addition prior to entering the treatment unit. When operated under the manufacturers' specified site conditions at a flow rate of 1.9 gpm ± 0.1 gpm, the Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 arsenic adsorption media filter system removed arsenic from the feed water to less than the detection limit (2 µg/L) for approximately 8,000 bed volumes, to less than 10 µg/L for approximately 25,000 bed volumes, and to less than the predetermined test endpoint (11 µg/L) after approximately 2,350 hours of total equipment operation for a total of approximately 29,000 bed volumes.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

The arsenic adsorption media filter system included Kinetico Inc.'s Para-Flo™ PF60 Model AA08AS filter unit, which includes two pressure filter tanks and a filter control module. The control module houses water-driven gears and mechanically interconnected pulse-turbine meter and valves to automatically initiate and control filter backwashes. The movement of the gears determines the position of the filter valves. Following the throughput of a set total volume of water, the pulse-turbine meter triggers the water-driven gears to manipulate valves, so that the operating mode of one filter is switched from service to backwash, to purge, and finally returns to service. During a backwash event, one filter supplies treated water for the backwashing filter and treated water effluent. The filter tanks operate in parallel when both are in service. Each filter was loaded with Alcan Chemicals' Actiguard AAFS50 media, a proprietary granular iron-enhanced activated alumina media. Literature for Alcan Chemicals' Actiguard AAFS50 media states that it is certified to NSF/ANSI 61.

The treatment unit is intended for use on groundwater supplies not under the influence of surface water serving small communities having limited manpower and operating skills. However, the technology is also scalable for serving larger systems. The filter system does not require electricity to operate and can operate continuously or intermittently. The filter components are modular in nature and can be installed by a qualified plumber. The tanks are freestanding, requiring only a level surface capable of supporting the weight of the unit, maintenance of ambient temperature above 35°F (1.7°C), and a feed water pressure between 30 and 125 psi.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was the Orchard Hills MHP WTP in Carroll Township, Pennsylvania. The source water was untreated groundwater from the WTP Well No.1, which is one of three wells currently

used to supply the MHP. The source water was of generally good quality, with relatively low turbidity, slightly basic pH, and moderate hardness of about 99 mg/L. The source water had a high concentration of manganese, 144 µg/L on average; an average total arsenic concentration of 14 µg/L, ranging from a minimum concentration of 12 µg/L to a maximum of 17 µg/L; an average iron concentration of 34 µg/L; an average silica concentration of 19.0 mg/L; and an average alkalinity concentration of 89 mg/L.

Methods and Procedures

Operations, sampling, and analyses were performed to provide an accurate evaluation of the treatment system under the field conditions. The verification testing was conducted in two phases. The first phase, the Integrity Test, was designed to evaluate equipment operation reliability under the environmental and hydraulic conditions at the WTP site during the initial two weeks of testing. The second phase, the Capacity Test, included testing designed to evaluate the capacity of the arsenic adsorption media filter system to remove arsenic from the Well No. 1 feed water.

The Integrity Test ran for 13 full days plus 8 hours, during which the field test operator was on-site to record test data twice per day. The treatment system was operated continuously using the manual mode of operation for Well No. 1 2 hours each day and operated intermittently during the remainder of each day. During the Capacity Test, the treatment unit operated intermittently in concert with the WTP well operation. The Capacity Test continued until an arsenic concentration of 11 µg/L was detected in the treated water for a minimum of 3 consecutive samples.

Flow rate, production volume, and pressure were monitored and recorded twice per day. Grab samples of feed and treated water samples were analyzed for pH, temperature, turbidity, alkalinity, calcium, magnesium, hardness, and fluoride by the field test operator. Grab samples were collected and delivered to the PADEP Laboratory for analysis of silica, aluminum, iron, manganese, chloride, sulfate, and total phosphorus. Arsenic samples were collected and sent to the NSF Laboratories for analyses. Sample collection for some water quality parameters was more frequent during the initial two-week Integrity Test period. Arsenic samples were also collected more frequently as the treated water total arsenic concentration approached the predetermined end-point concentration for a total number of 47 arsenic samples. Three sets of samples were speciated for arsenic during the Integrity Test, to determine the relative proportion of the total arsenic concentration that was soluble, that was in the As III species, and that was in the As V species. Samples for arsenic speciation were also collected periodically during the Capacity Test.

Complete descriptions of the verification testing results and quality assurance/quality control procedures are included in the verification report.

VERIFICATION OF PERFORMANCE

System Operation

The verification testing was conducted under the manufacturers' specified operating conditions. Contact time is a critical parameter for arsenic adsorption efficiency and is dependent upon maintaining the flow rate within the design range of 1.9 gpm ± 0.1 gpm. A non-integral pressure regulating valve and diaphragm valve on the treated water line were used to control and maintain the flow rate. A relatively constant flow rate was maintained with minimal flow rate adjustments required.

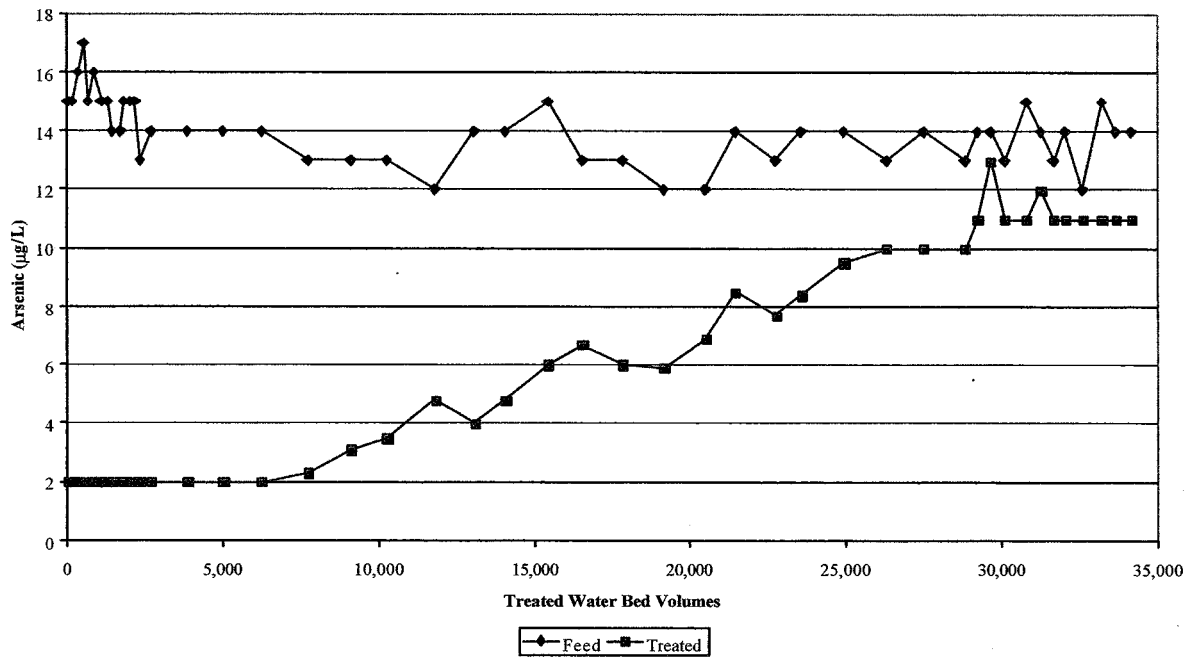
The system was operated continuously for a 2-hour period each day for the first 13 days plus 8 hours as part of the Integrity Test using the manual mode of operation for Well No. 1. The system operated intermittently in concert with the Well No. 1 operation during the remainder of the Integrity Test and throughout the Capacity Test. The filter unit operated for a total of 14.2 hours per day, on average.

The filter control module automatically initiates and controls backwashes based on a preset throughput volume. The treatment unit was set to backwash one filter following the throughput of approximately 10,500 gallons, plus or minus ten percent. A single filter was backwashed at a time. Therefore, each filter was backwashed every 21,000 gallons. Using the setscrew on the control module, filter backwashes were manually initiated at the end of the Integrity Test and monthly throughout the Capacity Test for the purpose of measuring backwash volume and testing backwash water quality. These manually initiated backwashes were performed for verification testing purposes only. Headloss across the filter unit averaged 1.1 psi during the test period, an amount only slightly greater than the 1.0 psi average headloss during the first two weeks of the test.

Water Quality Results

The feed water arsenic concentration averaged 14 µg/L, with approximately 4 µg/L as the arsenic III species and 10 µg/L as the arsenic V species. Treated water arsenic concentrations were less than or equal to the 2 µg/L detection limit during the initial 5 weeks of testing, or approximately 8,000 bed volumes of treated water. At the end of the verification test, the treated water arsenic concentration reached 11 µg/L following approximately 2,350 hours of equipment operation and treatment of approximately 28,800 to 29,200 bed volumes of water, based on the calculated media bed volume of 1.20 cubic feet. A steep breakthrough curve, which is typical with ion exchange processes, did not occur, as presented in Figure VS-1. The arsenic breakthrough curve may have been slowed by mixing of the filter media during filter backwashes.

Figure VS-1. Arsenic Breakthrough Curve
(Detection Limit = 2 µg/L)



At the beginning of the test, the treatment process reduced the pH from 7.3 in the feed water to 6.8 in the treated. As the media became conditioned by the feed water, the treated water pH increased such that, by the end of the first week of testing, the pH of the treated water was 7.5 compared to a pH of 7.7 in feed water. This pH reduction corresponded with a removal of alkalinity during the first two weeks of the test. Initially, the feed water alkalinity of 88 mg/L was reduced by 43%. However, by the end of the first week

of testing, the feed and treated alkalinity levels were essentially equal. The initial reduction in these water quality parameters was likely due to the acidic character of the coating on the virgin media.

Fluoride and silica were removed from the feed water initially, but as the total adsorption site area decreased, the preferentially favored arsenic ions out-competed the ions of fluoride and silica for the remaining adsorption sites. Initially, the feed water fluoride level of around 0.17 mg/L was reduced by up to 88%. Removal of this ion rapidly declined, so that by the end of the first two weeks of operation, fluoride was no longer being adsorbed by the media. Similarly, the initial feed water silica level of approximately 18 mg/L was reduced by up to 83%. Silica removal decreased within the first two weeks of operation to a range of 10% to 15% and remained at that level for approximately one month. Thereafter, levels of feed water and treated water silica were essentially equal.

The average feed water manganese level of 144 µg/L, which is almost three times the secondary maximum contaminant level of 50 µg/L, was reduced by an average 92% by the adsorption media. The initial treated water sulfate level (29.2 mg/L) exceeded the feed water sulfate level by 180%. Presumably, this was due to rinsing of excess coating from the media, which apparently contained a sulfate compound. After the first week of operations, the treated level of sulfate was only approximately 10% higher than the feed water sulfate. Thereafter, the feed and treated levels of sulfate were essentially equal.

The feed water total phosphorus level, which averaged 0.032 mg/L, was reduced during the entire period of verification testing. During the first 6 weeks of testing, between 60% and 70% of the total phosphorus was removed. Total phosphorus removal became more erratic thereafter, ranging between 20% and 68%. Turbidity was also reduced during the treatment process. However, concentrations of calcium, magnesium, hardness, aluminum, iron, and chloride were not significantly affected by the treatment process. Data tables presenting the on-site and laboratory water quality parameters collected during the Integrity Test and Capacity Test can be found in the verification report.

Operation and Maintenance Results

The two-phase verification test began on April 22, 2003 and ended following the conclusion of the Capacity Test on October 28, 2003. The treatment unit, including backwash cycles, operated automatically throughout the test. However, manually initiated backwashes were also performed as part of the testing process. Operator attention was required to verify and maintain a constant flow rate, to check for leaks in the piping and filter unit, and to verify that backwashes occurred as required based on throughput. Equipment operation required minimal operator attention.

Consumables and Waste Generation

No chemicals or electrical power were required. Wastewater from filter backwash, purge, and control module drive water was discharged to a sanitary sewer. The total water usage of approximately 83 gallons per backwash cycle represents less than 1 percent of the total finished water production.

Toxicity Characteristic Leaching Procedure (TCLP) and California Waste Extraction Tests (CA WET) were performed on spent Actiguard AAFS50 media. All concentrations of analyzed parameters were less than the current regulatory limits. A complete summary of the TCLP and CA WET results are provided in the verification report.

Quality Assurance/Quality Control

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a technical systems audit during testing to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

Original Signed by		*Original Signed by*	
Lawrence W. Reiter	*09/08/04*	*Gordon Bellen*	*09/23/04*
Lawrence W. Reiter	Date	Gordon Bellen	Date
Acting Director		Vice President	
National Risk Management Research Laboratory		Research	
Office of Research and Development		NSF International	
United States Environmental Protection Agency			

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and NSF make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end-user is solely responsible for complying with any and all applicable federal, state, and local requirements. Mention of corporate names, trade names, or commercial products does not constitute endorsement or recommendation for use of specific products. This report is not an NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents

Copies of the *ETV Protocol for Equipment Verification Testing for Arsenic Removal* dated April 2002, the verification statement, and the verification report (NSF report #04/08/EPADWCTR) are available from the following sources:
(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy)

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**MEMBRANE FILTRATION USED IN DRINKING WATER TREATMENT SYSTEMS**		
APPLICATION:	**REMOVAL OF ARSENIC**		
TECHNOLOGY NAME:	**WATTS PREMIER M-SERIES M-15,000 REVERSE OSMOSIS (RO) TREATMENT SYSTEM**		
COMPANY:	**WATTS PREMIER**		
ADDRESS:	**1725 W. WILLIAMS DRIVE, #C-20** **PHOENIX, ARIZONA 85027**	PHONE: FAX:	**(623) 505-1514** **(623) 931-0191**
WEB SITE:	**www.wattspremier.com**		
EMAIL:	**murphysp@wattsind.com**		

The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

NSF International (NSF) in cooperation with the EPA operates the Drinking Water Systems (DWS) Center, one of seven technology areas under the ETV Program. The DWS Center recently evaluated the performance of a membrane separations system for the reduction of arsenic in drinking water. This verification statement provides a summary of the test results for the Watts Premier M-Series M-15,000 Reverse Osmosis (RO) Treatment System. MWH, an NSF-qualified field testing organization (FTO), performed the verification testing. The verification report contains a comprehensive description of the test.

ABSTRACT

Verification testing of the Watts Premier M-Series M-15,000 RO Treatment System was conducted over a 31-day period from April 26, 2004, through May 26, 2004. This test was conducted at the Coachella Valley Water District (CVWD) Well 7802 in Thermal, California. The source water was a chlorinated groundwater supply. Based on the manufacturer's recommendations, the unit was operated at an average inlet pressure of 135 pounds per square inch (psi), water recovery of 53%, flux of 34 gallons per square-foot per day (gfd), and a specific flux of approximately 0.36 gfd/psi at 25 degrees Celsius (°C). The total arsenic (As) concentration in the feed water averaged 14 micrograms per liter (µg/L) during the testing period. The M-15,000 RO Treatment System reduced the arsenic levels to below detection (1.0 µg/L) for all but the last two samples, which were 1.4 and 1.2 µg/L. Six sets of samples were speciated and the dominant form of arsenic was As(V).

The system operated for 27 days of the 31-day verification period, with three system shut downs due to operational issues associated with the pre-filter. The verification study indicated that arsenic can be removed by the M-15,000 RO Treatment System, but depending on the source water characteristics, the appropriate pre-filter selection is important to prevent clogging of the pre-filters.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

The M-15,000 RO Treatment System contains six pressure vessels, each containing one 4" x 40" membrane module. Each stainless steel pressure vessel is four inches (10 cm) in diameter and approximately 45 inches (110 cm) long. The M-15,000 RO Treatment System is a skid-mounted unit that is constructed with a carbon steel frame and powder coating. The verification unit is 37 ¾" (length) x 28 ¾" (depth) x 53 ½" (height) and requires a minimum of 18" clearance on all sides for servicing, 40" clearance on top, and a floor sink drain of 1 ¼" diameter within 10' of the processing unit. The main components of the RO unit are a 3 Hp feed pump, carbon bloc (for removal of chlorine) or sediment pre-filter pretreatment, six pressure vessels, and an in-line conductivity meter. The M-15,000 RO Treatment System unit may use either a carbon pretreatment for removal of chlorine or a sediment pre-filter as standard equipment for the system. The membranes are not tolerant of chlorine and, therefore, when the system is used on a chlorinated water source, the carbon pretreatment should be used.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was the CVWD Well 7802 located in Thermal, California. The feed water for the verification study was a chlorinated source, with an average free chlorine residual of 0.47 milligrams per liter (mg/L). The chlorine enters the distribution system at the discharge manifold, and was fed from a Hammond's tablet feeder using calcium hypochlorite tablets as the chlorine source. The average feed water quality during the verification testing is provided in the table below.

In addition to being a suitable fit for water quality, the site also had sufficient access (1 acre site); full electrical supply with backup diesel powered generator; 6' privacy/security wall; all utilities readily available including raw water supply, power, and a drain (blow-off structure) for the discharge of the water from the ETV verification testing; and safety facilities, including an emergency shower and eyewash.

Average Feed Water Quality during Verification Testing

Parameter	Units	# of Samples	Average	Parameter	Units	# of Samples	Average
Total Arsenic	µg/L	27	14	Turbidity	NTU[3]	5	0.40
Dissolved Arsenic	µg/L	5	14	Conductivity	umoh/cm	54	231
As (III)	µg/L	5	3.7	TDS	mg/L	27	140
As(V)[1]	µg/L	5	11	TSS	mg/L	5	< 10
TOC	mg/L	5	< 0.50	Manganese	µg/L	5	< 2.0
Calcium	mg/L	5	4.8	Iron	mg/L	5	0.019
Chloride	mg/L	5	8.5	Barium	µg/L	5	7.1
Hardness	mg/L	5	18	Silica	mg/L	5	15
Alkalinity	mg/L	5	83	Fluoride	mg/L	5	0.80
Free Chlorine	mg/L	18	0.47	Sulfate	mg/L	5	20
Total Chlorine	mg/L	18	0.51	Chromium	µg/L	5	13
pH[2]	--	27	9.21[3]	Vanadium	µg/L	5	49
Temperature	°C	54	27.5				

[1] As (V) is a calculated value.
[3] pH is reported as the median, not the average.
[3] Nephelometric Turbidity Unit(s).

Methods and Procedures

Water quality was monitored from three water streams: feed water, permeate, and concentrate. Conductivity, pH, turbidity, chlorine (free and total), temperature, alkalinity, hardness analyses were conducted on-site, using equipment set up in the pump house at CVWD Well 7802 and in accordance with *Standard Methods for the Examination of Water and Wastewater, 20^{h} edition*. Conductivity and feed water temperature were monitored twice per day, while pH was monitored once per day. Alkalinity, hardness, chlorine, and turbidity were monitored once per week on-site using methods approved by NSF. The following additional samples were sent to MWH Laboratories for analysis: arsenic (total, dissolved, and As^{+3}), total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC), silica, barium, calcium, chloride, sulfate, iron, manganese, fluoride, chromium, and vanadium. Total arsenic and TDS samples were collected once per day; dissolved arsenic, As^{+3}, TSS, TDS, TOC, silica, barium, calcium, chloride, sulfate, iron, manganese, fluoride, chromium, and vanadium samples were collected once per week. One sample was collected during the verification test for silt density index (SDI) analysis. Complete descriptions of the verification testing results and quality assurance/quality control procedures are included in the verification report.

VERIFICATION OF PERFORMANCE

System Operation

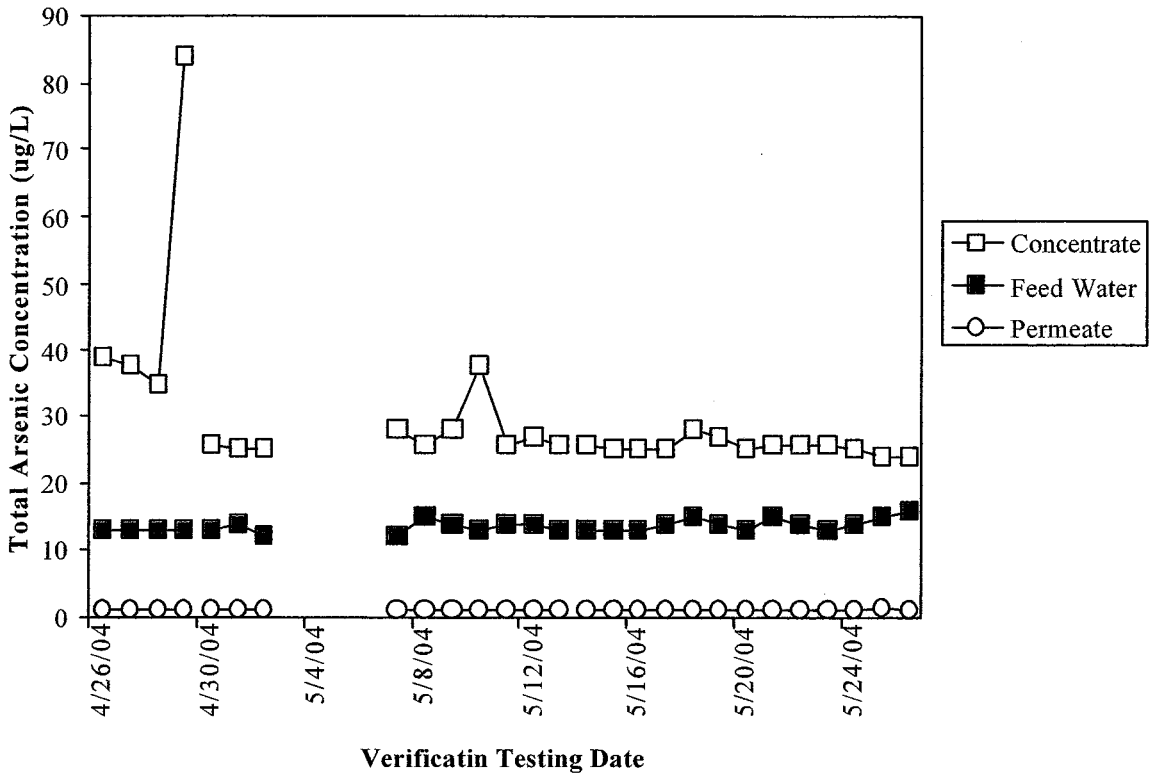
RO is a pressure-driven process, with the pressure used for separation by allowing fresh water to move through a membrane, leaving various dissolved constituents of the water behind. In the M-15,000 RO Treatment System, feed water is initially passed through a pre-filter (sediment filter or carbon bloc for chlorine removal) to remove particles that have the potential to damage the membrane. There is a sampling port just prior to the pre-filter to collect the feed water samples. After passing through the pre-filter, the feed water is blended with re-circulated concentrate water and is then referred to as the inlet water. The inlet water is then sent through a booster pump and after leaving the discharge side of the pump, the water line is split and feeds the two separate banks of membranes (six membranes in total), starting with membrane 1 and 4. For the first bank of membranes, concentrate from membrane 1 feeds membrane 2 and concentrate from membrane 2 feeds membrane 3. For the second bank of membranes, concentrate from membrane 4 feeds membrane 5 and concentrate from membrane 5 feeds membrane 6.

Permeate from all membranes is collected from the bottom of the housing and exits the unit as drinking water. There is a permeate sample port for each of the six membranes, as well as the blended permeate from all six of the membranes. During the verification test, permeate samples were collected from the blended permeate sample port. Concentrate from membranes 3 and 6 is split, some being purged to waste and some re-circulating back to the head of the system, just after the pre-filter where it is blended with the feed water to create the inlet water. The concentrate that is re-circulated back to the head of the system is referred to as recycle water.

The M-15,000 RO Treatment System was set up in accordance with the manufacturer's recommendations the week prior to the verification test. The unit was tested to make sure all systems were operating in accordance with their recommended ranges. Based on discussions between the FTO and the manufacturer, the set points were adjusted to achieve a 50% permeate recovery. Once the set points were adjusted, the system flow rates were stable for the remainder of the verification period. The feed water pressure was stable throughout the testing period, however, the inlet pressure varied from 102 to 145 psi, due to clogging of the carbon bloc pre-filter. Once the pre-filter was replaced with a sediment filter, the inlet pressures stabilized (140 to 150 psi) for the remainder of the verification testing.

Water Quality Results

The M-15,000 RO Treatment System removed the feed water total arsenic from 14 µg/L (on average) to non-detectable levels (<1.0 µg/L) for all but the last two samples collected, which were 1.4 and 1.2 µg/L. As shown in the figure below, the unit was able to produce a consistent, high quality permeate with total arsenic levels below 1.0 µg/L in 95% of the samples over the range of feed water of 12 to 16 µg/L. Throughout most of the verification test, the total arsenic mass balance was very close, with the exception of April 29, 2004, and May 10, 2004, where the arsenic concentration in the concentrate stream was significantly higher (greater than the 95% confidence interval), at 84 µg/L and 38 µg/L respectively. The permeate conductivity and TDS slowly increased throughout the verification testing, starting around 6.4 umoh/cm and increasing to 76.6 umoh/cm for conductivity and starting at <10 mg/L and increasing to 45 mg/L for TDS. During the verification testing, a total of five weekly samples were collected for inorganic analyses. Based on these five samples, the M-15,000 RO Treatment System removed on average: >72% barium, >79% calcium, 85% fluoride, 85% chloride, >92% chromium, >90% sulfate, >93% vanadium, 38% iron, and 62% silica. Manganese was also sampled and analyzed during the verification testing, but the percent removal could not be determined due to non-detectable (<2 µg/L) levels for all of the feed water and permeate samples.



Temporal Plot of Total Arsenic

Operation and Maintenance Results

The system ran continuously for 27 of the 31-day verification testing period. For one 4-day period, the system was shut down due to operational issues. Clogging of the carbon bloc pre-filter is believed to be the cause of the shut down. The unit automatically shut down on two separate occasions, also believed to be related to clogging of the carbon bloc pre-filter. On May 13, 2004 the carbon bloc pre-filter was replaced with a 20-micron sediment pre-filter. The system ran continuously after the sediment filter was installed, until the end of the verification testing on May 26, 2004, when the system was manually shut down.

Quarterly maintenance was conducted upon completion of the verification testing. The maintenance procedure took approximately 45 minutes to change out the O-rings on the pre-filter and brine line, and replace the pre-filter and two of the six RO membranes. Upon completion of the maintenance procedures, the system was started back up and both water quality and operational conditions were recorded. The specific flux immediately prior to the maintenance was 0.34 gfd/psi and upon start up after the maintenance was 0.33 gfd/psi, thus a 97% recovery of specific flux was achieved upon completion of the maintenance procedures.

Consumables and Waste Generation

There were no "consumable" chemical items used for the verification testing; however, the pre-filter to the system would be a consumable product and would have to be disposed of as solid waste. The concentrate waste stream produced from the verification test was blended back with the permeate water for an equivalent water quality to the feed water from the CVWD Well 7802. This water was then sent to a blow-off structure for disposal. The estimated concentrate production rate was 17,300 gallons per day, based on the targeted 50% permeate recovery.

Quality Assurance/Quality Control

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a technical systems audit during testing to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

Original Signed by Sally Gutierrez for Lawrence W. Reiter	*09/30/04*	*Original Signed by Gordon Bellen*	*09/30/04*
Lawrence W. Reiter	Date	Gordon Bellen	Date
Acting Director		Vice President	
National Risk Management Research Laboratory		Research	
Office of Research and Development		NSF International	
United States Environmental Protection Agency			

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and NSF make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end-user is solely responsible for complying with any and all applicable federal, state, and local requirements. Mention of corporate names, trade names, or commercial products does not constitute endorsement or recommendation for use of specific products. This report is not an NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents

Copies of the *ETV Protocol for Equipment Verification Testing for Arsenic Removal* dated September 2003, the *ETV Protocol for Equipment Verification Testing for Removal of Inorganic Constituents* dated April 2002, the verification statement, and the verification report (NSF Report # 04/16/EPADWCTR) are available from the following sources:
(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy)